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THE PHILIPPINE AGRICULTURIST

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INCREASING CORN PRODUCTION IN INDONESIA THROUGH PLANTING OF LONGER MATURING VARIETIES [1]

R. I. JACKSON [2]

WITH FOUR TEXT FIGURES

A highly significant and positive correlation was obtained between yield of corn and number of days to maturity. The average daily increase in yield of dry grains ranged from 0.74 gram to a plant in low fertility tests to 1.92 grams in high fertility tests. By replacing the very early maturing varieties with ones requiring 10 to 15 days more or longer, a large increase in corn production can be expected without the use of more land. Still greater gains can be made with the use of green manure and/or fertilizers. Varieties maturing in approximately 110 days should be used wherever possible.

After rice, corn is the most important food crop in Indonesia. The postwar period has seen a great shortage of both cereals. There are three acceptable agricultural practices that might be employed to overcome the deficiency without increasing the labor devoted to production: first, more land may be put into cultivation by using power machinery to underwrite the extra work load; second, green manure and/or fertilizers may be applied to stimulate production; third, adapted improved varieties may be planted in lieu of present lower producing varieties.

Implementing the first of these three possibilities poses several obstacles. In the first place, most of the arable land is in Java and Madura, heavy population centers, and is already under cultivation. This leaves the alternative of opening up new land in some of the less densely populated islands, in which case a considerable outlay of cash would be involved as relatively few of the farmers in these islands are financially able to purchase the needed power equipment. Machinery pools are being established by the government to increase man-hour production in some areas, but there are still large areas not served by these pools.

Probably the quickest and surest way of increasing the corn yield in Indonesia is by using fertilizers and green manure in combination with new improved varieties of corn. Wherever possible, these new varieties should be longer maturing than those now commonly planted in Indonesia. It is the aim of this paper to show how

[1] Miscellaneous Contribution No. 29. From the General Agricultural Research Station, Bogor, Indonesia.

[2] Corn Breeder from the U. S. Operations Mission to Indonesia. The author wishes to express his appreciation to the General Agricultural Research Station at Bogor and to the U. S. Operations Mission to Indonesia for the cooperation afforded him in his study. Photographs by Sudidjan were furnished by the General Agricultural Research Station.

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a substantial increase in yield per hectare can be expected from the longer maturing varieties of corn.

Wolfe [3] reported that the correlation coefficients between yield of grain and number of days to tasseling and to silking of corn variety Silver King were negative. According to him, "unpublished data at the Virginia Experiment Station indicate that corn plants which tassel and silk early mature late and yield high. Thus, a negative correlation is to be expected between yield per plant and the time at which corn plants tassel and silk. It has been commonly observed that, as a rule, the variety that matures latest, other things being equal, will give the highest yield."

In a study of 461 crosses, Jenkins [4] found that yield was correlated positively with characters indicating length of season required to reach maturity. Snedecor and Cox [5] studied inbred lines derived from 14 varieties and observed that in most cases there was a tendency for the yield of the inbreds to increase with decreased time to appearance of first silks. This can be interpreted as an indication that longer maturity is associated with higher yield.

EXPERIMENTAL RESULTS AND DISCUSSION

In August, 1951, the General Agricultural Research Station requested the Agricultural Inspectors of Indonesia to send to the Bogor Station corn seed representative of that grown in their areas. A questionnaire asking about the cultivation of each variety accompanied the request. In answer, samples of varieties grown in about one-fourth of the total corn area of Indonesia were sent to Bogor. On the assumption that the data reflected by the questionnaires were usably accurate, the land planted to corn was grouped as to the elevation where the corn was grown and the length of maturity of the variety (table 1). The number of hectares planted to the varieties in each class was determined in terms of percentage of the total area reported on. Two significant facts were revealed: one, that 65 per cent of the corn is grown at an elevation between sea level and 250 meters, and two, that more than 54 per cent of the corn planted requires less than 90 days to mature. In other words, most of the corn planted in Indonesia has a short maturity period and is grown at low elevations, principally on the coastal plains of Java.

Some of the varieties sent to the General Agricultural Research Station were planted in three experiment gardens in Java located at Bogor, Modjosari, and Muneng. The plantings were made on February 29, March 7, and March 10, 1952, respectively. Each test was laid out as a 6×6 triple lattice with three replications, and two different tests were planted in each garden. A fourth planting was made at Genteng with two tropical American varieties for the purpose of comparing them with four varieties released by the General

[3] T. K. Wolfe, *Virginia Agric. Exper. Sta. Tech. Bull.*, 26 (1924).
[4] Merle T. Jenkins, *Jour. Agric. Res.*, 39, 677 (1929).
[5] George W. Snedecor and Gertrude M. Cox, *Jour. Agric. Res.*, 54, 449 (1937).

Agricultural Research Station and with two of the better varieties submitted by the Agricultural Inspectors.

The soil at the Bogor garden has been described as a young, brown, andesite tuff. Cassava had been grown the previous year on the ground used for the test plots. Furthermore, the land was in a low state of tilth and fertility. One of the two tests was discarded because of a poor stand caused by ants destroying the seeds shortly after planting. Many of the remaining plants were attacked later by the rice seedling fly (*Antherigona exigua* Stein). The second test was not as severely attacked; however, two varieties failed to grow and only 34 were tested.

The soil at Modjosari is a heavy, young, gray ashy loam. Because of the severe waterlogging of this soil, the germination and vegetative growth were not as good as could be desired. Furthermore, previous to and immediately following the planting at Modjosari, there was much rain. Four weeks after planting, the plants showed symptoms of nitrogen deficiency. Even though ammonium sulfate was added immediately, the plants made about the same poor growth as those at Bogor. On the bases of vigor, appearance, and yield of the plants, the tests at Bogor and Modjosari were called "low fertility" trials.

The two tests at the Muneng garden were made on soil described as a gray-brown loam; the parent material is andesitic ash. The seedbed was well prepared at the time of planting. The seeds germinated well. The final stand was good. The plants made a normal growth and were vigorous. The dry season usually begins in March in this garden and 1952 was no exception. For sufficient moisture, the tests were surface-irrigated.

The soil at Genteng is a brownish-black volcanic ash and has been classified as a sandy and gravelly tarapan. On April 23, 1952, a 3×3 triple lattice with nine replications was planted. The plants had excellent growth partly because of three applications of ammonium sulfate at weekly intervals starting when the plants were three weeks old. Each application was at the rate of three quintals per hectare. Judged by the same criteria used for the tests in the other two gardens, the tests at Muneng and Genteng were considered "high fertility" tests.

The entries in the tests made in the four gardens were planted in hills one-half meter apart and in two rows one meter apart. The plants were thinned to two to a hill. The chiefs at Modjosari and Muneng were instructed to apply ammonium sulfate in the same manner as at Genteng. The plot at Bogor received one application of ammonium sulfate at the rate of one quintal per hectare when the plants were four weeks old.

In order that the yields and other plant characteristics of the varieties could be compared in the two tests in each garden, seven of the varieties used in each test were identical. One variety in the collection matured too late and was not included in the final data.

Fig. 1.—Maturity of four varieties of corn planted at Bogor. The varieties are, from left to right, 651, Berangan, Empalizada, and 142–48. They require 80, 90, 100, and 110 days to mature. Note the height of 142–48.

Sixty-four different varieties were tested at Muneng and Modjosari, 34 varieties at Bogor, and nine at Genteng. In general the varieties at Bogor and Modjosari yielded about half as much as those grown under the much better conditions at Muneng and Genteng.

The ears were weighed at harvest and again when they were air-dry. From these two weights the percentage of air-dry matter in the grains of each variety at the time of harvest was determined. Another study at Bogor revealed that corn increases in dry matter by about one-half per cent a day during the final stages of maturation. By using both the percentage of air-dry matter and the relative gain in dry matter, it was possible to group the corn varieties into different lengths of maturity, each group differing from the next by five days. The earliest varieties fell into the 80-day group, and the latest, into the 110-day group. A variety was described as mature when it was found to have 67.5 to 70.0 per cent air-dry matter. In the test at Muneng 50 per cent of the varieties matured in 90 days or less; at Modjosari, 53 per cent; at Bogor, 56 per cent; and at Genteng, 33 per cent. The planting at Genteng was primarily designed to test later maturing varieties. The entries for the other tests were

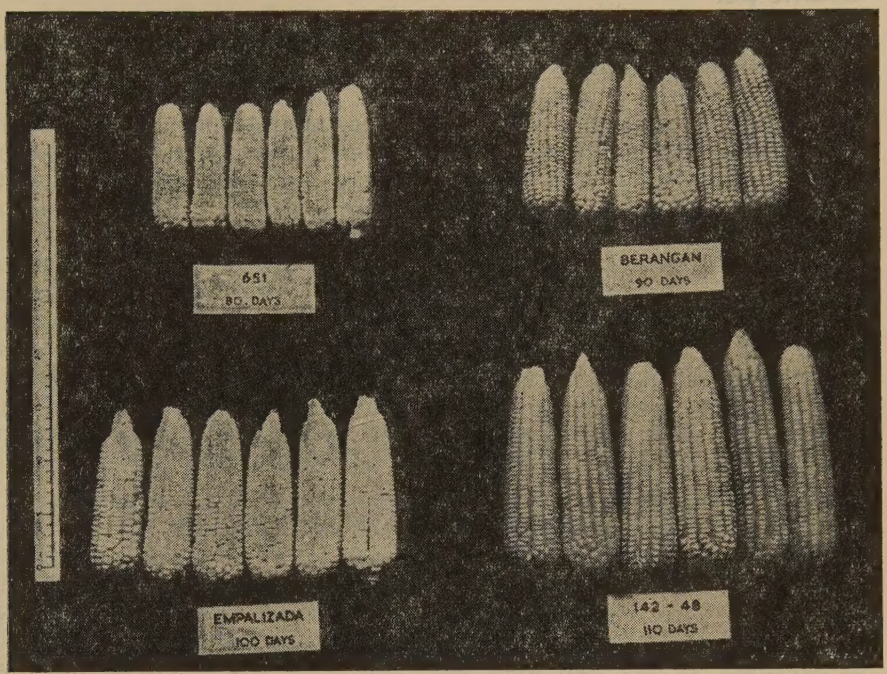

Fig. 2.—Ears of the four varieties shown in figure 1. Note that the ears of the late variety are at least twice as large as those of the early variety. This comparison corresponds to the yield per hectare.

chosen from the materials sent in by the Agricultural Inspectors after first being observed in a nursery at Bogor.

After the varieties had been classed according to maturity, the average class yield of the varieties was determined (table 2). Upon first examination, there appeared to be a direct relationship between the yield of a plant and the number of days to maturity. To test this hypothesis statistically, correlation coefficients were calculated. All of them were statistically significant at odds of 99 to 1 or greater (table 3). Thus, it is clearly shown that for these tests there is a positive relationship between yield and number of days to maturity.

To determine the magnitude of the effect maturity had upon yield, regression coefficients were also calculated. All of them were highly significant (table 3). The coefficients for the trials grown under poor fertility conditions were less than those for trials grown under better soil conditions. The latter were nearly twice as great as those for the varieties grown in a low state of tilth and fertility. In both cases, it is evidently possible to increase the daily production of a unit of land by planting longer maturing varieties. It is possible to increase production significantly without an increase in land area.

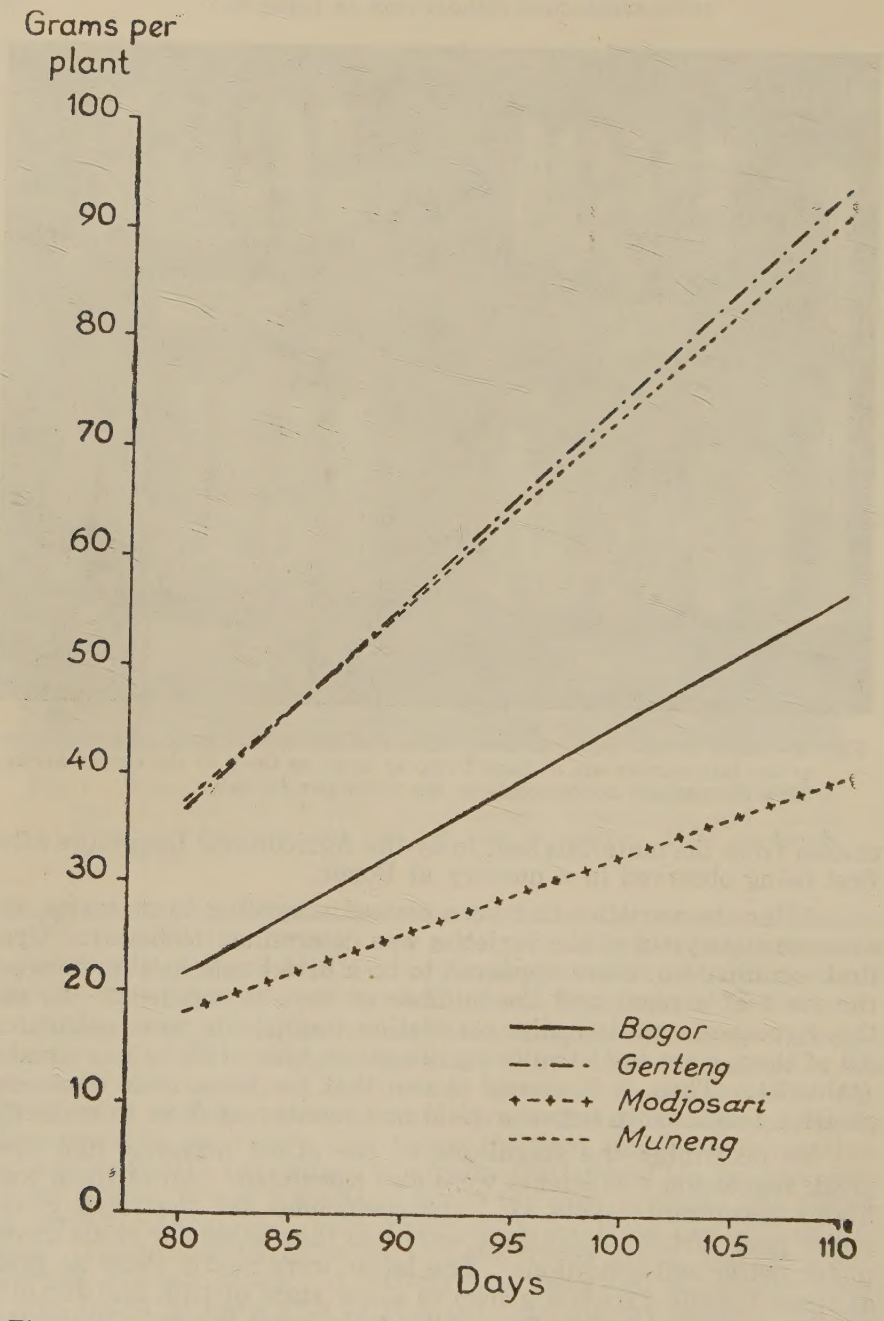

Fig. 3.—Regressions of yield of a plant on days to maturity. The equation for each line follows:

Bogor	$Y = 1.19x - 73.57$
Genteng	$Y = 1.92x - 117.08$
Modjosari	$Y = 0.74x - 41.25$
Muneng	$Y = 1.79x - 105.56.$

As an example of the increase in production given by longer maturing varieties, the Bogor plot showed a daily average dry-matter gain of 1.19 grams to a plant for every day over the 80 days required for maturity. Thus, if a 90-day variety is grown in place of an 80-day one, an average increase of 11.9 grams to a plant can be expected if growing conditions are similar to those in this test. For 100- and 110-day varieties, increases of 23.8 and 35.7 grams to a plant can be expected. The approximate plant population density for this test was 30,000 plants per hectare. By first multiplying the daily increase by the number of days over the 80 days required for the variety to mature and by multiplying this product by the plant population, the predicted increases in yield would be 3.57, 7.14, and 10.71 quintals per hectare for 90-, 100-, and 110-day varieties, respectively. In May, 1952, the market price for corn in Djakarta was Rp 151.25 per quintal.[6] The values of the increased amounts of corn produced on one hectare if the 80-day varieties were replaced by those indicated above would be Rp 539, 1079, and 1619, respectively.

In figures 1 and 2 the plant and ear characteristics of varieties requiring 80, 90, 100, and 110 days to mature can be compared. These four varieties were planted on August 13, 1952, at Bogor. The ears of the 110-day variety, 142-48 from Central America, are fully twice as large as those of variety 651 maturing in 80 days. This same comparative difference is also true for plant height. The two photographs emphasize the yield gain that can be expected by planting longer maturing varieties.

The four regression lines from the four trials are plotted in figure 3. The lines of regression were tested for linearity according to the method of Snedecor.[7] All of them were found to be straight lines. The equation for each line is given just below figure 3. In the higher yielding tests, the regression coefficients were twice as large as those for the tests grown under low fertility. Thus, it clearly becomes important to improve both the soil tilth and fertility and to plant, wherever possible, superior varieties which mature later than those now commonly used in Indonesia.

In figure 4 the production of grain is shown as the average amount the plant produces a day over the period from time of planting until harvest. If nutrients essential for good plant development are deficient, as at Bogor and Modjosari, then a 90- or 95-day variety is the most efficient grain-producing plant on a daily basis, but an improved 110-day variety still yields the most corn. If nutritional elements are not so limiting, the 110-day varieties are the most efficient plants, as shown by the data from Genteng and Muneng. As stated earlier, it becomes very apparent that corn production per unit of land can be greatly increased in Indonesia by increasing the level of tilth and fertility and by planting longer matur-

[6] Anonymous, *Warta Ekonomi*, 5, 663 (1952).

[7] George W. Snedecor, "Statistical Methods," The Iowa State College Press, Ames, Iowa, 1946.

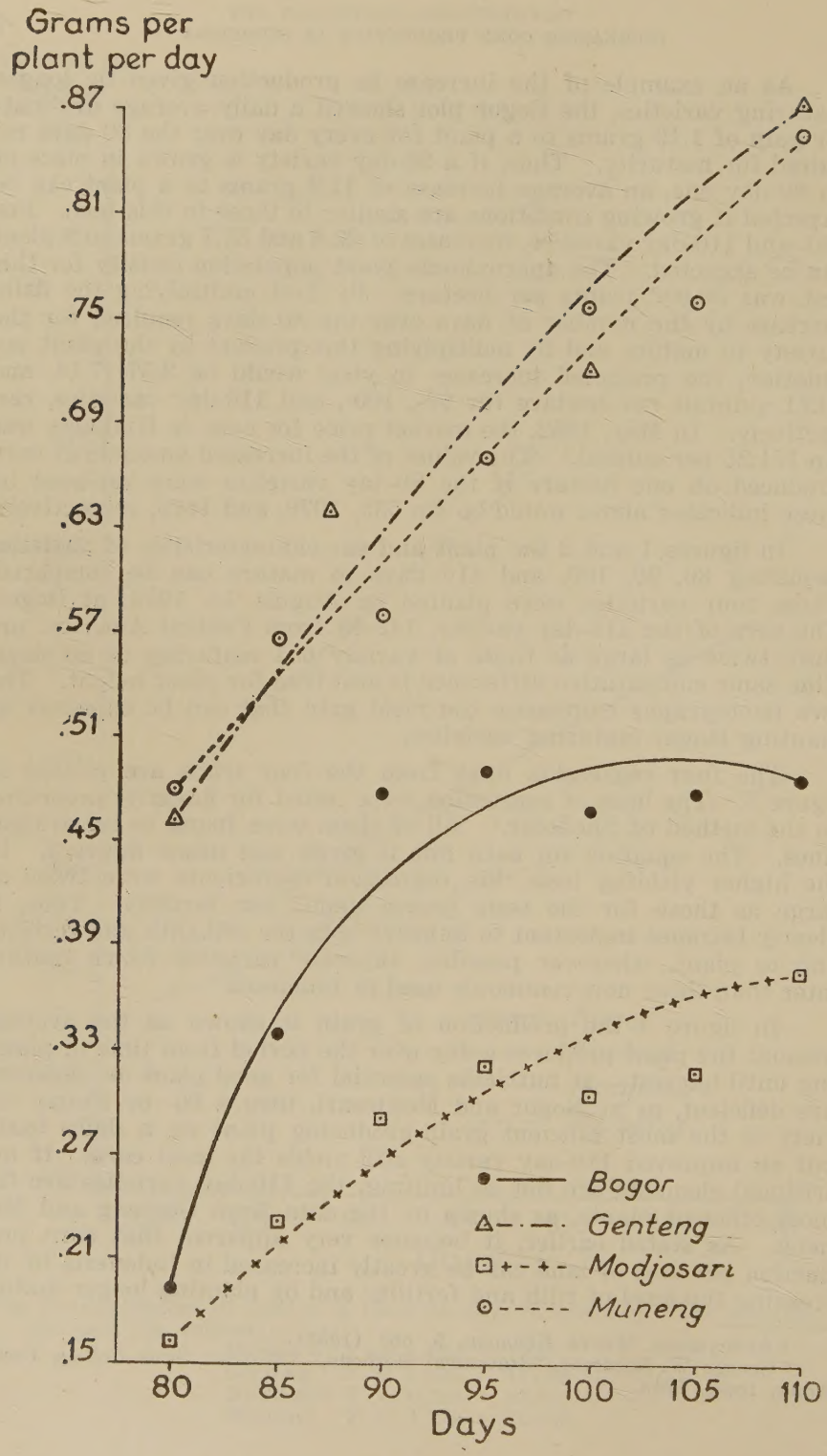

Fig. 4.—The average amount of dry grains one plant produces in a day over the period from time of planting until harvest.

ing, improved varieties. Even when the early dwarf varieties are replaced with an improved medium-early variety requiring 95 days to mature, an immediate and significant increase in yield can be expected.

CONCLUSION

To increase the corn production in Indonesia, two sound agricultural methods should be put into practice as quickly as possible. One is the use of fertilizer. Unpublished data from Bali record significant increases in yield of corn from the use of *Crotalaria anagyroides*. After two crops of Crotalaria, an increase in yield of 65 per cent over the check or unmanured plots was obtained. By planting Crotalaria and fertilizing it with one quintal of ammonium sulfate per hectare, the yield increased by 95 per cent.

A second method is the use of longer maturing and improved varieties of corn wherever possible. It is evident from the data presented that very significant increases in yield can be expected from the varieties requiring a longer length of maturity than those now commonly planted. There are areas, however, in which it may be difficult to shift away from the early varieties. No doubt short-maturing varieties are used in part because corn is a catch crop following rice, which needs most of the wet season. A limited food supply forces some farmers to use a short- rather than a long-maturing variety to provide food for themselves and their families. An adjustment in farming practices might provide a solution. If it would be possible to plant longer maturing varieties either by direct replacement of the early one or by a change in present practices, the return to the farmer in increased yield would be substantial.

TABLE 1

Percentage of land planted to corn grouped according to three elevation levels and six maturity periods

ELEVATION IN METERS	DAYS OF MATURITY						TOTAL FOR EACH ELEVATION GROUP
0–250	13.47	28.71	20.17	0.46	0.37	1.49	64.67
251–750	0.11	12.07	0.59	12.77	2.43	4.48	32.45
751–1500	—	0.06	0.07	0.26	0.17	2.32	2.88
Total for each maturity group	13.58	40.84	20.83	13.49	2.97	8.29	100.00

TABLE 2

Number of varieties and average yield of a plant in each maturity group

LOCATION OF TEST	DAYS OF MATURITY													
	80		85		90		95		100		105		110	
	No. of varieties	Average yield of a plant	No. of varieties	Average yield of a plant	No. of varieties	Average yield of a plant	No. of varieties	Average yield of a plant	No. of varieties	Average yield of a plant	No. of varieties	Average yield of a plant	No. of varieties	Average yield of a plant
		grams		*grams*		*grams*		*grams*		*grams*		*grams*		*grams*
Bogor	5	15.4	12	28.7	2	43.0	2	46.5	4	46.7	6	50.0	3	53.3
Modjosari	1	13.0	4	19.7	29	26.1	8	30.6	10	30.3	2	33.5	10	41.1
Muneng	1	38.5	19	48.3	11	52.2	12	63.7	4	75.7	7	79.7	9	93.8
Genteng	2	37.0	—	—	2	57.5	—	—	3	72.0	—	—	3	95.6

TABLE 3

Coefficients of correlation and regression between yield and maturity of corn tested at four gardens

LOCATION OF TEST	CORRELATION COEFFICIENTS	REGRESSION COEFFICIENTS YIELD ON MATURITY
Bogor	0.8201 [a]	1.19 grams to a plant a day [a]
Modjosari	0.7166 [a]	0.74 " " " " " " [a]
Muneng	0.6812	1.79 " " " " " " [a]
Genteng	0.8041 [a]	1.92 " " " " " " [a]

[a] Significant at odds of 99 to 1 or greater.

THE EFFECT OF HERBICIDES ON WEEDS IN RICE FIELDS [1]

MARCOS R. VEGA

WITH FOUR TEXT FIGURES

Barnyard grass or watergrass (*Echinochloa crusgalli* [Linn.] Beauv. Gramineae) was considered the most serious of the weeds in the rice fields because it was difficult to kill with 2,4-D sprays. Morphological changes and eventual kill of the weed were effected when 2,4-D was sprayed on the seeds and on young seedlings up to 15 days of age. Older seedlings did not succumb to the spray. Rice seeds and young seedlings up to 15 days old produced very irregular stand when sprayed with 2,4-D. When sprayed at one month of age the rice plants showed the least damage in terms of decreased grain yield. Rice plants sprayed at different ages showed varying degrees of abnormal development.

Apparently, the most expedient concentration to use is 1000 ppm. 2,4-D acid equivalent at the rate of 5 gallons per 1000 sq. ft. The best time to apply the herbicide in the field is about fifteen days after transplanting the rice seedlings. The seedlings have had enough time to recover, they are at least thirty days of age and, hence, less susceptible to the spray, and the weed seedlings have not passed their susceptible stage. Three out of four trials on the effect of 2,4-D on one-month-old rice plants showed that the spray significantly lowered the yield. Spraying should be done only when the expected damage from the weeds will exceed the damage from the spray.

The discovery that 2,4-dichlorophenoxyacetic acid and its derivatives can selectively kill weeds without affecting the crop is a boon to the farmers. These chemicals are effective on broad leaves and tend to be ineffective on grasses. The rice farmers, however, can not take full advantage of the selectivity of the chemicals because most of the pernicious weeds of rice are grasses like itself.

An important lead was brought out by Dersheid and his coworkers (1952, 1953) when they reported that the stage of growth of oat plants was the most important single factor conditioning the extent of injury that they sustained from 2,4-D sprays. The writer thought that if rice and the grass weeds react to 2,4-D similarly, then the spraying of the field can be timed so that the chemical will destroy the weeds without markedly harming the rice crop. The approach was believed to be promising because rice plants generally differ in age from the weeds that infest the field.

The experiments were conducted from December, 1952, to January, 1954, in rice fields in Calamba, Laguna,[2] and in pots and experimental plots in the Department of Agricultural Botany.

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[1] Central Experiment Station Contribution No. 1762. Thesis presented for graduation, April, 1954, with the degree of Bachelor of Science in Agriculture from the College of Agriculture. Prepared in the Department of Agricultural Botany under the direction of Dr. Jose R. Velasco.

[2] The writer acknowledges the kindness of Mr. Jose Carreon of Calamba for allowing the use of his fields and of Mr. Francisco Elauria for his cooperation during the experiment. Thanks are also due Dr. Mercedes B. Uichanco for placing her rice field at the writer's disposal.

MATERIALS AND METHODS

Two forms of 2,4-D were used in this study, namely: (1) Weed-B-Gone, a triethanolamine salt of 2,4-D, containing 9.6 per cent acid equivalent, and (2) isopropyl ester of 2,4-D, containing 44 per cent acid equivalent.[3] The herbicides were used as aqueous solutions, and the dilutions were made on the basis of the active ingredients of the stock preparation. Fresh aqueous solutions were used in all the experiments. In pot experiments, a hand sprayer was used for applying the herbicide; in field and plot experiments, a knapsack sprayer was used.

Pots with drainage holes were used for growing upland rice, and pots without drainage holes, for growing lowland rice and barnyard grass or water grass (*Echinochloa crusgalli* [L.] Beauv.) All the pots were painted with coal tar on the inside. Soil used in each experiment was mixed well to insure its uniformity in the culture pots.

The heights of rice plants were measured and the tillers counted at intervals in all pot experiments. The field experiments in Calamba were visited at regular intervals, and observations were made and recorded. Photographs of culture plants were taken whenever necessary.

The culture pots were transferred to wire cages after emergence of panicles to protect them from pests. Mature grains were harvested from each culture, dried, and weighed.

EXPERIMENTS AND RESULTS

Preliminary observations

Survey of weeds in the field. To decide which were the most troublesome weeds, the writer surveyed weed species and their relative abundance in a typical lowland rice field in barrio San Jose, Calamba. The land was prepared on November 17, 1952, and was planted with 10-day-old dapog seedlings on December 17, 1952. The field was divided into two lots. Lot I, which was lower in elevation, was planted to Malagkit; lot II, higher in elevation, was planted to Dinoradong Calamba. Three 1-square-meter portions were laid out at random in each lot. The weeds were counted on January 7, February 15, and April 1, 1952. In the first counting lot II had no water; in the second counting, both lots had water; and in the last counting, both lots had no water because the rice grains were past the milk stage.

It may be mentioned that during the second counting, the barnyard or watergrass plants were about a meter high and were much taller than the rice plants. Some of them were already flowering. At the final counting, the barnyard or watergrass plants had already shed off some of the grains at the base of the panicles.

---

[3] The writer gratefully acknowledges this gift of 2,4-D from the Shell Company of the Philippines.

In general there were more weeds in lot II (table 1), which was not submerged during the early seedling stage. On the other hand, continuous submergence of the field when the seedlings were newly transplanted produced pale-green, unhealthy plants.

The most numerous weed in both lots was umbrella plant (*Cyperus difformis* L.). It completely covered the spaces between the hills of rice. Although its number was progressively reduced as the rice advanced in age, the weed visibly exerted some detrimental effects on the rice plants. The latter were pale green and had few tillers.

In spite of the attempt to select plots which were representative of the general field, the data obtained were limited in scope. To supplement the information on the plots, therefore, a cursory survey was made of the weeds in the whole field and in the neighboring fields. The most numerous weeds belonged to the family Cyperaceae (table 2). Previous experiments in the College (Capinpin and Ocfemia, 1948) showed that they are susceptible to 2,4-D sprays. Other weeds like *Monochoria hastata* (L.) Solms., *Monochoria vaginalis* (L.) Presl., *Alternanthera ficoides* (L.) R. Br., and *Eclipta alba* (L.) Hassk. were demonstrated to be likewise susceptible. Lucero (1953) reported that grass weeds, especially barnyard grass or watergrass, are resistant to herbicidal spray.

To obtain more data which might be used in formulating a control for barnyard grass or watergrass, experiments were conducted almost exclusively with this weed.

Percentage germination of barnyard grass or watergrass. Immature panicles of barnyard grass or watergrass growing in one of the culture tanks in the Department of Agricultural Botany were placed under a bell jar to provide them with sufficient light for proper development of the grains and to ensure that all their seeds would be gathered. The barnyard or watergrass plant was about a meter high, and the immature grains were green with a purplish tinge at their base. The grains turned brown towards maturity and dropped off very readily. When all the grains were mature the panicles were harvested. Most of the panicles had shed off their grains.

The grains were rubbed between the hands to remove their brown covering, then placed in a basin of water to determine which were filled and which were empty. It was arbitrarily decided that those which sank were filled and those that floated were empty. The filled grains were gray whereas the empty grains were whitish. The grains were dried and counted. There were 960 filled grains and 204 empty grains, or a total of 1164 grains, in a panicle. This was the average of two observations.

To find the percentage of germination, 100 filled grains were planted in each of two pots containing lowland soil, and the germinating seeds were counted at regular intervals. This experiment was repeated with another panicle using four pots with 100 seeds each. Germination was noted as early as four days after planting and con-

tinued for 19 days. The percentage of germination obtained in these experiments ranged from 57 to 74 per cent (table 3). The range of germination in Garcia's experiment (1931) was 53.0 to 83.5 per cent at 90 per cent saturation of the soil.

There was a strong indication that light is an important factor in the germination of barnyard or watergrass seeds. Several attempts at germinating seeds in the diffused light of the laboratory yielded only about four per cent germination at the most. Full sunlight was then used in all subsequent germination experiments.

Reaction of barnyard grass or watergrass to 2,4-D

Influence on germination. The common observation is that barnyard or watergrass plants in any cropping season arise almost exclusively from seeds. In this respect, they differ from other grass weeds like para grass (*Panicum purpurascens* Raddi) or torpedo grass (*Panicum repens* L.) which can arise from suckers, runners, or rhizomes. It is therefore possible to control this weed by simply preventing the germination of its seeds.

Concentrations of 2,4-D ranging from 100 to 1000 ppm. were prepared, and a 5-milliliter amount of each was placed in a Petri dish. One hundred seeds of barnyard grass or watergrass were placed in each Petri dish, and daily counts of germinating seeds were taken. There was a gradual decrease in percentage of germination from distilled water to 500 ppm. (table 4). In addition, there was a delay of two days in the germination of the treated seeds. While the seedlings that grew in distilled water were about two centimeters at 11 days of age, those that grew in 2,4-D solutions were no more than 1 centimeter and were chlorotic and had poorly developed roots (fig. 1). Beyond 500 ppm. no germination occurred. Since rice plants were shown to be hardly injured by this concentration of 2,4-D pre-emergence spraying of barnyard grass or watergrass seems to be a practical method of controlling it.

Fig. 1.—Barnyard grass or watergrass seeds grown on filter paper wet with different concentrations of 2,4-D. Left to right: 0, 100, 200, 300, 400, and 500 ppm. (*Photographed by the Photographic Division*).

The adsorptive capacity of the soil for 2,4-D, however, had to be considered in deciding on a spray concentration to use. To find out what concentration to apply to the soil, seeds planted in pots were sprayed with 2,4-D ranging in concentration from 600 to 1000 ppm.

The herbicide was applied at a computed rate of 384 liters per hectare (40 gal./acre).

There were very small, inconsistent differences in percentage germination between the unsprayed and the sprayed lots (table 5). Although the postulated high adsorptive capacity of the soil for 2,4-D was discounted, the results of the two experiments might still be reconciled by considering that 2,4-D solution bathing the seeds in the Petri dish could have found its way into the embryos and killed them. On the other hand, the casual contact of the spray with the weed seeds in the pot experiment did not allow sufficient penetration of the shiny, impermeable seed coat by the solution; hence the undiminished percentage of germination. It may, however, be gathered that as the young plant broke through the seed coat and reached the 2,4-D in the soil, it became inhibited in growth (table 5a). This seems to show that 2,4-D is primarily a growth inhibitor and incidentally a germination inhibitor.

Influence on growth. Lucero (1953) attributed his failure to control barnyard grass or watergrass which were about a foot tall to the relative resistance of the plants to 2,4-D at that stage. To gain a better understanding of the reaction of the plant to the herbicide, several lots of barnyard grass or watergrass were germinated in pots. Lot I was not sprayed; lot II received the spray 15 days after planting; lot III, 30 days; lot IV, 45 days; and lot V, 60 days. Weed-B-Gone, a triethanolamine salt of 2,4-D, was diluted with water to make 1000 ppm. and sprayed at 5 gallons per 1000 sq. ft. (approximately 218 gal./acre or 2100 liters/ha.). This rate of spraying was recommended by Avery and Johnson (1947).

The plants sprayed 15 days after planting showed abnormal bending of leaves. One week after spraying most of the plants were dead. Out of 40 plants in this lot, only three plants survived (table 6). The survivors were at first stunted in growth and had few tillers. They however recovered and produced flowers about 20 days later than the unsprayed plants (lot I).

Among plants sprayed at 30 days of age, there was greater divergence of the tillers than among the unsprayed plants so that each clump appeared more widespread. There was some retardation of growth in height (table 6).

Spraying at 45 days of age did not produce any visible effect on the plants. In two pots in this culture the 20 plants did not flower until the end of the experiment.

At 60 days of age, the plants were flowering or about to flower. Only those plants that were about to flower were sprayed to determine the effect of the spray on flowering. The flowers emerged at about the time the unsprayed plants flowered, and the panicles were apparently normal. It seems that for best results, 2,4-D spray should be applied not later than at one-half month of age of the plants.

Loustalot (1952) showed that grasses could be killed by 2,4-D when a longer time of contact was allowed between the grass leaves

and the 2,4-D solution. He suggested that the more impermeable cuticle of the grasses was their main defence against 2,4-D. Once the herbicide gained entrance into the system of the weed, it caused damage to the plant as it would to any other plant. This view lends justification to Craft's (1946) suggestion that a nonpolar solvent which rapidly permeates the cuticle, like a mineral oil, should be the vehicle of 2,4-D as a spray against grasses.

Reaction of rice to 2,4-D

Influence of spraying before planting. Herbicides can be used either before or after the crop is planted. When they are sprayed before planting, the principal concern of the farmer is how soon the crop can be planted without injury from the herbicides in the soil.

In the untreated pots the seedlings started to emerge from the ground five days after planting. They were very healthy. The seedlings in culture II started to emerge in five days also, but they were rather chlorotic and had a totally inhibited root development (fig. 2, left). The coleoptile was distorted and much elongated, measuring 35 mm. as against 8 mm. in normal seedlings. There was elongation of the first internode and inhibition of the first true leaf, which did not come out of the coleoptile. Usually, untreated seedlings develop a long coleoptile and first internode only when planted deep into the soil where oxygen tension and sunlight are inadequate.

Eight days after planting, approximately eighty per cent of the food stored in the endosperm of the untreated lot, but only 30 to 40 per cent of that of the treated lot, was used up. By May 1, 1953, or 13 days after planting, all the seedlings in lot II were dead (table 7).

In lot III planted one week after spraying, the seedlings started to come out six days after planting. Some seedlings were green and others were chlorotic.

The seeds which were planted two weeks after spraying (lot IV) emerged from the soil in five days. They were all green and apparently healthy.

It seemed that 1000 ppm. 2,4-D applied at 5 gallons per 1000 sq. ft. (2100 liters/ha.) became innocuous after two weeks in the soil under lowland conditions.

Influence of spraying at different stages of the plant. Although preplanting treatment of the field is practical, subsequent operation calls for disturbance of the soil and probable bringing up to the surface of some weed seeds in the lower levels. These seeds may in turn germinate, and the farmer has to spray just the same when the crop is in the field. It is desirable, then, for him to know when his crop is most susceptible so that he can avoid spraying at that stage.

Sixteen pots were planted to Thailand, a lowland rice variety, on December 8, 1952. They were divided into four lots of four pots each. Lot I was not sprayed and served as the control; lot II was sprayed one month after planting; lot III, two months after plant-

Fig. 2.—Effect of 2,4-D on Elon-elon rice seeds grown under lowland conditions. The four seedlings at the left were sprayed with 1000 ppm. 2,4-D at the rate of 5 gal./1000 sq. ft. immediately after planting. Note the total inhibition of roots in the treated seeds as compared with the untreated at the right. Note also the marked elongation of coleoptile in treated seedlings (up to about 35 mm. against 8 mm. in the untreated ones.) There was also elongation of first internode, inhibited development of first true leaf which did not come out of the coleoptile, and at a later stage, drying up of tip of the coleoptile. Planted April 17, 1953; sprayed April 17, 1953; picture taken April 25, 1953. (*Photographed by the Photographic Division*).

ing; and lot IV, three months after planting. The spray solution had a strength of 1000 ppm. and was applied at 5 gallons per 1000 sq. ft. (2100 liters/ha.)

The ideal conditions of lowland rice culture were maintained. The height of the plants and the number of tillers were taken at 42, 69, and 98 days of age. When the panicles had emerged, the pots were placed inside a wire cage to prevent damage of the grains by birds and insect pests.

Those plants sprayed at one month showed visible damage from 2,4-D. Two days after spraying, the tillers diverged markedly from the vertical, and the angle between the leaf sheath and the blade approximated 90 degrees (fig. 3). Normally, the angle between them is close to 180 degrees. These modifications gave a disheveled appearance to the plants, as if they had been buffeted by a wind that changed direction every so often. Later on the leaves turned yellowish and the plants apparently did not grow at all. When young leaves were eventually produced, they were distorted and did not come out with ease from the confining leaf sheaths of the older leaves. They were, however, dark green. When two to three leaves had come out, the sprayed plants looked more healthy than the unsprayed ones.

The plants in lot I flowered on February 19; those in lot II, on February 26, 1953. By the time the plants had reached the flowering stage, the adverse effects of 2,4-D were no longer evident.

The plants sprayed at two months (lot III) showed less twisting and bending than those of lot II. They likewise no longer showed the effects of the spray when they flowered on February 26.

Lot IV was flowering when the spray was applied. Bending of the stems at the nodes and spreading of the tillers were noted. The plants did not recover from the damage until maturity. Instead of maturing in 136 days as in lot I, the grains in lot IV ripened much later.

Although lot II was stunted in growth for some time after the treatment, the effect was only temporary (table 8). On the other hand, lots III and IV were stunted in growth up to the time of the final measurements. No clear indication could be gathered as to the effect of the spray on the number of tillers (table 8a). The yield of grains was reduced in lots III and IV to almost half that of lot I, the unsprayed lot (table 8b). The least decrease in grain yield was observed in lot II. The difference was significant.

As it is of interest to know the reaction of an upland variety to 2,4-D, Inintiw rice variety was planted under upland conditions. Six lots of four pots each were treated as follows: lot I, unsprayed; lot II, sprayed at the time of sowing (June 3, 1953); lot III, sprayed one-half month after planting; lot IV, sprayed one month after planting; lot V, sprayed two months after planting; lot VI, sprayed at booting or 85 days after planting. The concentration of 2,4-D

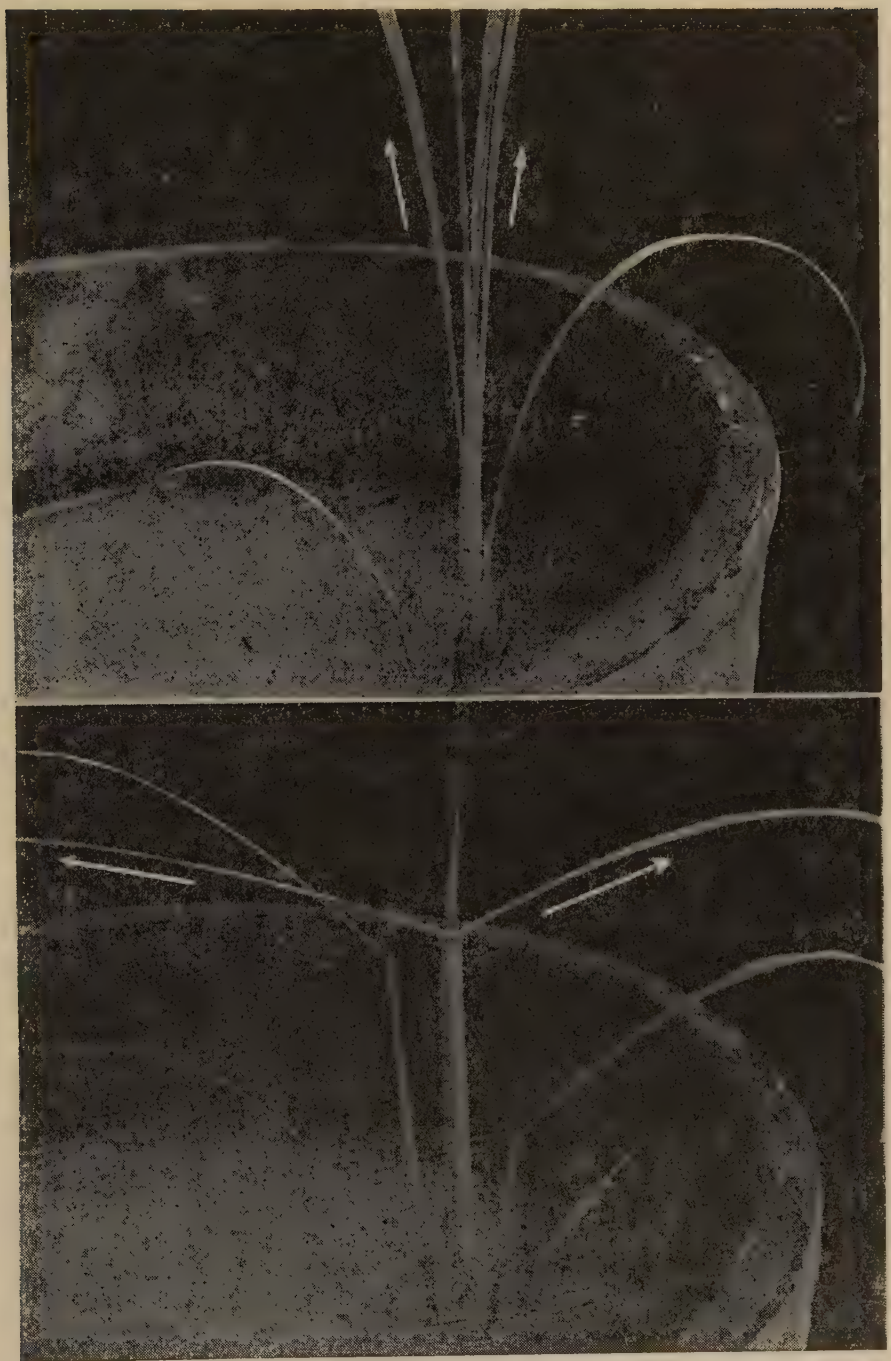

Fig. 3.—Upper panel, lowland rice plant, variety Thailand, sprayed with 1000 ppm. 2,4-D at the rate of 5 gal./1000 sq. ft. at one month of age. Note the almost 90° angle between the leaf blade and leaf sheath of the sprayed plant as compared with the almost 180° of the untreated plant in the lower panel. Planted Dec. 8, 1952; sprayed Jan. 8, 1953; photographed Jan. 13, 1953. (*Photographed by the Photographic Division*).

(Weed-B-Gone) was 800 ppm., and it was applied at 5 gallons per 1000 sq. ft. (2100 liters/ha.).

Although the seedlings in lot II germinated at the same time as the control, they did not grow normally. The coleoptile and young leaves were twisted and the plants were not erect. The very young seedlings of the sprayed lot turned yellow and remained that way until they were about one month of age.

The sprayed lot was free from weeds for some time, but on the unsprayed lot weeds like *Eleusine indica* (L.) Gaertn, *Euphorbia hirta* L., *Amaranthus spinosus* L., *Portulaca oleracea* L., and *Ipomoea triloba* L. grew at random.

The plants sprayed one-half month after planting (lot III) started twisting four days after spraying. In the ensuing leaf there was atrophy of the mesophyll at one side and hypertrophy on the other, resulting in distortion and wrinkling (fig. 4). It took about thirty-four days for the plants to recover from the injury.

Fig. 4.—Upland rice, variety Inintiw, sprayed with 800 ppm. 2,4-D at one-half month of age. Note the leaf fasciation formed in the sprayed plant, left, and the great difference in blade-to-leaf sheath angle between the treated plant and the untreated plant at right. Planted June 3, 1953; sprayed June 18, 1953; photographed July 10, 1953. (*Photographed by the Photographic Division.*)

Lot IV which was sprayed at one month of age showed the same type of injury as the other sprayed lots, though in a lighter degree.

The only visible effect on the plants sprayed at two months of age (lot V) was spreading of the tillers.

In the plants sprayed at booting (lot VI) some panicles did not emerge evenly. In these panicles the main part came out normally, leaving the tip securely entrenched in the leaf sheath of the flag leaf.

The spray had apparently no hastening or retarding effect on the maturity of the grains, but it had a temporary adverse effect on the height of the plants (table 9) and was apparently detrimental to tillering if applied anytime from planting to one month after planting (table 9a). The highest yield of grains (table 9b) was obtained in lot IV which was sprayed one month after planting.

Influence of different concentrations of spray on one-month-old rice plants. There was a strong indication in the previous experiment that the one-month-old rice plants suffered the least damage in yield from 2,4-D spray. To find out what concentration of 2,4-D can be tolerated by rice plants at this stage, several lots of Thailand rice were started on June 15, 1953. At one month of age lot I was not sprayed with 2,4-D to serve as control; lots II, III, and IV were sprayed with 500, 1000, and 1500 ppm. Weed-B-Gone, respectively; and lots V, VI, and VII with 500, 1000, and 1500 ppm. of isopropyl ester of 2,4-D, respectively. The rate of application was 5 gallons per 1000 sq. ft. (2100 liters/ha.).

A day after spraying, the leaves exhibited the characteristic changes previously described. The least change was observed in the plants sprayed with 500 ppm. 2,4-D. There was apparently no difference between the equal concentrations of triethanolamine salt and isopropyl ester of 2,4-D. Mullison (1952) found that in the descending order of effectiveness isopropyl ester was followed by the alkanolamine, the free acid, the ammonium salt, and the sodium salt form.

The adverse effect on height of the higher concentrations of spray was most pronounced at 60 days of age of the plants, or one month after spraying (table 10). At 90 days, however, the plants had fully recovered and generally were taller than the unsprayed plants. The tillers of the treated plants, especially those given the higher concentrations, were fewer than those of the untreated plants (table 10a) The yield of lot II, treated with 500 ppm. triethanolamine salt of 2,4-D, was about two grams less, but that of lot V, treated with 500 ppm. isopropyl ester of 2,4-D, was about eight grams less than the control. The difference between lots I and II was insignificant, but the differences between lot I and the rest of the lots were significant. This somewhat confirms the finding of Mullison (1952) on the relative effectiveness of the two compounds of

2,4-D. The least yield was obtained from lot III which was sprayed with 1500 ppm. triethanolamine salt of 2,4-D.

Influence of spraying on root development. The yellowish leaves resulting from treatment with 2,4-D attracted the writer's attention. It was not quite the same yellowing due to nitrogen deficiency. It was more like the yellowing that results from waterlogged soil. To find out how the roots are affected by a spray of 2,4-D on the leaves, 15-day-old seedlings were started on Espino's 4-salt solution on August 14, 1953. On September 3, one lot was sprayed with 1000 ppm. 2,4-D solution.

One day later, the sprayed plants were bent at the base, assuming a ruffled appearance. One week after the treatment, no new roots were found on the sprayed plants, but the untreated ones had several young roots of varying lengths growing out of the crown. In addition, the roots of the treated plants turned dull brown, whereas those of the untreated plants were shiny white. It took about two weeks for the sprayed plants to produce new roots. By that time it was clear that the original roots were dead and disintegrating. The bases of the leaf sheaths became swollen, cracks then occurred, and distorted tillers came out of the cracks. Also, roots of deep-seated origin pushed their way through these swollen bases.

On October 1, 1953, the plants were harvested. It was incidentally noted that the sprayed plants were brittle. Tables 11 and 11a present the number of roots and the green weight of the plants, respectively. The sprayed plants weighed less than one-third of the unsprayed plants.

Pot and field experiments on weed control

Spraying with 2,4-D before planting of rice. One promising method of controlling weeds is to spray the field after the last harrowing preliminary to planting. This is calculated to inhibit the germination of weed seeds or to allow abnormal germination which leads to ultimate death. A few days are allowed to elapse before the rice seedlings are planted so that the herbicide will be rendered innocuous by the physico-chemical and biological reactions in the soil.

Pots of soil were prepared for lowland culture and were divided into lots of four pots each. On May 12, 1953, 200 barnyard grass or watergrass seeds were planted in each pot. The soil was turned over once to simulate final harrowing. Lot I was left unsprayed to serve as control; lots IIa, IIb, and IIc were sprayed with 1000, 1500, and 2000 ppm. isopropyl ester of 2,4-D; and lots IIIa, IIIb, and IIIc were sprayed with 1000, 1500, and 2000 ppm. of Weed-B-Gone. The rate was 5 gallons per 1000 sq. ft. One week later, 15-day-old rice seedlings were planted at the rate of two seedlings to a pot.

Nine days after planting, barnyard grass or watergrass seedlings were noticed in the untreated pots. Two days later the weed was also noticed in the 1000 ppm. lots of both formulations of 2,4-D. A

few days later, the weed seeds were germinating in all the lots. On May 25, 1953, or about one week after transplanting, untoward effects of the herbicides were noticed on the rice seedlings. While the control plants were dark green, the treated plants were yellow and the leaf blades hang limply from the leaf sheaths. Among the lots of different concentrations of spray, the degrees of injury did not differ. On June 2, 1953, some of the seedlings started to recover while others remained half-dead, resulting in a very irregular stand within lots. It was decided to discontinue this experiment, and on June 8, 1953, the seedlings were harvested. Their heights were taken (table 12) and the germinating weed seeds were counted (table 13). Like the rice seedlings, the barnyard grass or watergrass seedlings were dark green and healthy in the control lot and pale and slender in the treated lots. There was a decrease of rice plants in the lots treated with 2,4-D, but there was also a decrease in number of germinating weed seeds.

Influence of 2,4-D on the crop and the weed. Another promising method of control is to spray established rice seedlings of about one month of age to eliminate the young weed seedlings.

Six lots of four pots each were prepared on June 29, 1953. Lot I was planted to Thailand rice alone and did not receive 2,4-D treatment; lots II, III, and V were planted to rice on June 29 and to barnyard grass or watergrass on July 14; and lots IV and VI were planted to rice on June 29 and to barnyard grass or watergrass on July 29. In addition, lots III and IV were sprayed with 1000 ppm. 2,4-D on July 29, and lots V and VI, with 500 ppm. 2,4-D. In other words, lots II, III, and V had one-month-old rice seedlings and 15-day-old barnyard grass or watergrass seedlings at the time of spraying, whereas lots IV and VI had one-month-old rice seedlings and barnyard grass or watergrass seeds. The 2,4-D was applied at the rate of 5 gallons per 1000 sq. ft. Although 100 barnyard grass or watergrass seeds were planted, germination was quite uneven so that the weed seedlings in lots II, III, and V were thinned down to 45 plants to each pot before spraying.

Two days after spraying, the barnyard grass or watergrass seedlings in lots III and V twisted and bent. The injury was greater in lot III than in lot V. A week later, the barnyard grass or watergrass seedlings in lot III were already rotting, but in lot V they were apparently recovering. In lots IV and VI the barnyard grass or watergrass seeds had not germinated one week after planting. Thirteen days after planting, some weed seeds germinated in lot VI, but none germinated in lot IV even at the end of the experiment. The number of weeds in the different lots is given in table 15.

The barnyard grass or watergrass plants in lot II, which was not sprayed, were stunted and chlorotic. This was probably due to their being very crowded. They did not outgrow the rice plants and did not apparently cause any harm to them.

The spray caused some damage to the rice plants as reflected in a temporary retardation of growth in height (table 14) and a de-

crease in the number of tillers (table 14a). The ultimate damage in terms of decrease in grain yield may be gleaned from table 14b. Lot I gave the highest yield; lot II, where the weeds did not prosper, was next; lots V, IV, and III followed in the descending order. The differences were significant. Out of four trials (tables 8b, 9b, 10b, and 14b) three proved that 2,4-D spray at 1000 ppm. significantly lowered grain yield.

In Louisiana ¾ pound of 2,4-D (acid equivalent) per acre is sprayed on three- to four-week-old rice plants three to six days before flooding. After the plants have been flooded two to three weeks, rates of 1¼ to 1½ pounds of 2,4-D per acre cause no injury to the rice and give good weed control. Computed on a concentration of 1000 ppm., ¾ pound 2,4-D acid per acre is equivalent to 90 gallons of spray. On the other hand, 5 gallons per 1000 sq. ft. (the rate in this experiment) is equivalent to 218 gallons per acre.

Spraying in the field. Six lots of 10 × 10 feet were chosen at random in Mr. Jose Carreon's rice field and planted to 10-day-old Malagkit rice seedlings on June 4, 1953. On July 1, three lots were sprayed with 1000 ppm. 2,4-D (Weed-B-Gone) at the rate of 5 gallons per 1000 sq. ft. The field was drained before it was sprayed, and the water was restored about one week after spraying. The weed population of the lots was surveyed after spraying. The weeds were principally *Cyperus difformis* L., with a little *Echinochloa crus-galli, Monochoria hastata, Monochoria vaginalis,* and *Eclipta alba.* Lots I, III, and V, which were treated, hardly had any weeds after spraying (table 16). Lots II, IV, and VI, which were not sprayed, had slightly less weeds in the second than in the first counting, but not remarkably less.

The sprayed rice plants showed the usual signs of 2,4-D spray injury, but they recovered in about 49 days. Both the sprayed and the unsprayed lots were harvested on October 11. The unsprayed lots had a slightly higher average yield of grains than the sprayed lots (table 17). The difference was not significant.

Some experiments were conducted in other fields, but they were either discontinued or were found to be unreliable because the tenants ignored the requests of the writer to keep off the staked lots.

DISCUSSION

Although the members of the family Cyperaceae constitute the most numerous weeds in the lowland rice fields, they are not a serious problem because they are much more susceptible to 2,4-D sprays than rice. The grass weeds, especially barnyard grass or watergrass, are among the hardest to control because they have almost the same reaction to herbicide as the rice crop. An herbicide which will kill them will likewise kill the rice plants.

The experiments on the effect of 2,4-D on the germination of barnyard grass or watergrass seeds showed that when kept in continuous contact with 2,4-D solution in Petri dishes, seeds did not ger-

minate in 600 ppm. and higher concentrations. However, when the seeds were in the soil, sprays of 2,4-D at as high a concentration as 1000 ppm. did not prevent their germination. A heartening observation was that the seedlings which arose from seeds receiving this concentration of sprays were abnormal and did not live long.

The studies on the effect of 2,4-D sprays on the different stages of barnyard grass or watergrass showed that beyond 15 days of age the weed was not killed by 2,4-D at 1000 ppm. It would seem that for best results, the field should be sprayed when the weeds are 15 days old or younger. The spray will not prevent the germination of weed seeds, but since the seedlings will be abnormal and will die soon after germination, they should not present a serious problem.

One of the effects of 2,4-D on rice seeds was complete inhibition of germination. However, when two weeks were allowed to elapse between spraying of the field and sowing of the seeds, the rice seedlings developed normally. It may be presumed that preplanting sprays are not advisable in lowland rice culture because there is a great tendency for the subsequent operations to bring up weed seeds from the lower levels. Presowing sprays may be practical in upland rice culture because only the upper few inches of soil are disturbed in sowing and covering the seeds.

Fifteen-day-old rice seedlings might have been adversely affected by the spray, but one-month-old seedlings could withstand the spray and showed the least damage in terms of decreased grain yield.

It seems that the best time to apply the herbicide in the field is about 15 days after transplanting the rice seedlings. The seedlings have had enough time to reestablish themselves. They are 30 days old and, hence, less susceptible to the spray, whereas the weed seedlings have not passed their susceptible stage.

Of the concentrations tried, 500 ppm. least injured the rice plants but could not completely keep down the weeds. On the other extreme, 1500 ppm. caused marked reduction in yield. Apparently, 1000 ppm. is the best concentration.

In the field trials, the sprayed lots tended to have lower yields than the unsprayed lots despite the fewer weeds in the former. The situation might have been different had the field been much more weedy. In this instance, the weeds reduced the yield less than did the damage from 2,4-D spray. This will emphasize the need for judiciousness in applying 2,4-D in the field.

Several field experiments started in the rice fields of Calamba came to nought because the farmer concerned did not fully appreciate the value of the experiment in which he had agreed to cooperate. It may be advisable in the future to lease the piece of land under experiment and to supervise it closely.

Although this study supplies information on the suitable time to apply the spray and on the concentration to use, it does not elaborate on the amount of spray to apply to a given area. The rate

of 5 gallons per 1000 square feet cited by Avery and Johnson (1947) was, except in one instance, adopted in all the experiments. This is one phase of the study that should be looked into.

Other problems cropped up during this study. One was the probable effect of fertilization on the severity of weed infestation. Another was the apparent uneven incidence of weeds in the dry- and wet-season cultures. Also, there seemed to be distinct differences in the ecological requirements of weed species.

As an herbicide, 2,4-dichlorophenoxyacetic acid has some limitations. It does not kill cogon grass (*Imperata cylindrica* Koenig), one of the serious weeds in upland and kaingin rice fields. There should therefore be no flagging in the search for better herbicides. This search should be especially intensified in the Philippines because our tropical environment is very favorable to the growth of diverse kinds of plants, especially weeds.

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TABLE 1

Number and kinds of weeds in a typical lowland rice field during a dry-season culture

REPLICATION	DATE OF COUNTING	NUMBER OF WEEDS COUNTED							TOTAL
		Cyperus difformis	*Echinochloa crusgalli* (L.) Beauv.	*Monochoria hastata* (L.) Solms.	*Eclipta alba* (L.) Hassk.	*Alternanthera ficoides* (L.) R.Br.	*Panicum purpurascens* Raddi	*Panicum repens* L.	
Ia	Jan. 7	813	4	6	33	0	0	0	856
	Feb. 15	185	6	0	0	0	7	0	198
	Apr. 1	121	5	0	0	0	7	0	133
Ib	Jan. 7	392	0	0	6	0	0	0	398
	Feb. 15	42	6	0	0	0	10	11	69
	Apr. 1	30	6	0	0	0	10	11	57
Ic	Jan. 7	375	0	8	3	0	0	0	386
	Feb. 15	56	1	13	0	1	0	0	71
	Apr. 1	36	1	9	0	1	0	0	47
IIa	Jan. 7	1,358	7	26	164	9	0	0	1,564
	Feb. 15	165	8	12	117	0	10	19	331
	Apr. 1	120	7	8	68	14	9	10	236
IIb	Jan. 7	1,042	5	27	39	12	0	0	1,125
	Feb. 15	192	5	7	10	8	5	9	236
	Apr. 1	118	0	6	7	6	5	9	151
IIc	Jan. 7	1,015	3	19	46	3	0	0	1,088
	Feb. 15	120	3	5	20	1	4	4	157
	Apr. 1	102	3	4	15	0	4	4	132

TABLE 2

Distribution and abundance of different weeds in lowland rice fields

FAMILY	SCIENTIFIC NAME	LOCATION	RELATIVE ABUNDANCE
Cyperaceae	*Fimbristylis miliaceae* (L) Vohl	Along sides of dikes and on paddies	Very abundant
	Cyperus pilosus Vohl	On dikes	Few
	Cyperus difformis L.	On paddies	Very abundant
Compositae	*Eclipta alba* (L) Hassk.	On paddies	Many
	Eclipta zippeliana BR.	On sides of dikes	Few
Pontederiaceae	*Monochoria vaginalis* (L) Presl.	On paddies	Many in some field but none in others
	Monochoria hastata (L) Solms.	Along sides of dikes and on paddies	Many
Gramineae	*Panicum repens* L.	On paddies	Many
	Panicum purpurascens Raddi	On dikes and paddies	Many
	Echinochloa crusgalli (L) Beauv.	On paddies	Few
Amaranthaceae	*Alternanthera ficoides* (L) R.Br.	On paddies and on sides of dikes	Not so many

TABLE 3

Percentage germination of barnyard grass or watergrass

POT NUMBER	NUMBER PLANTED	NUMBER GERMINATED	PERCENTAGE GERMINATION
First replication			
1	100	74	74
2	100	59	59
Second replicataion			
1	100	66	66
2	100	65	65
3	100	70	70
4	100	57	57

TABLE 4

Percentage germination of barnyard grass or watergrass seeds in different 2,4-D concentrations [a]

CONCENTRATION IN PPM.	DISH 1	DISH 2	DISH 3	AVERAGE
First trial:				
0	23	29	12	21.3
100	21	7	30	19.3
200	12	5	15	10.7
300	21	1	7	9.7
400	4	5	0	4.5
500	12	1	0	6.5
Second trial:				
0	35	45	33	37.7
100	24	31	20	25.0
200	17	15	13	15.0
300	2	8	3	4.3
400	6	0	14	10.0
500	0	2	3	2.5

[a] One hundred seeds were started in each Petri dish; in 600–1000 ppm. there was no germination.

TABLE 5

Germination of soil-grown barnyard grass or watergrass receiving different spray concentrations [a]

	CONCENTRATION IN PPM. OF 2,4-D					
	0	600	700	800	900	1000
First trial:						
Sept. 14, 1953						
a	8	2	1	3	3	5
b	1	3	9	1	1	5
c	2	6	4	6	4	4
d	0	11	6	1	4	2
Sept. 16, 1953						
a	32	27	22	34	17	23
b	22	25	25	8	26	16
c	29	17	22	26	23	30
d	16	15	17	16	19	25
Sept. 22, 1953						
a	13	12	12	0	7	18
b	14	8	4	9	11	17
c	17	17	9	14	14	15
d	18	8	15	14	8	1
Sept. 29, 1953						
a	1	0	2	0	1	0
b	0	0	0	1	0	2
c	0	0	0	7	0	1
d	1	0	2	2	0	0
Total germination:						
a	54	41	37	37	28	46
b	37	36	38	19	38	40
c	48	40	35	53	41	50
d	35	34	40	33	31	28
Average	43.5	37.8	37.5	35.5	34.5	41.0
Second trial:						
Oct. 23, 1953						
a	13	12	11	10	8	6
b	6	17	15	12	10	13
c	10	5	7	9	10	15
Oct. 27, 1953						
a	1	0	0	0	2	3
b	0	4	5	0	0	5
c	1	0	0	0	0	4
Oct. 31, 1953						
a	1	0	0	0	0	1
b	0	0	2	0	0	1
c	0	0	0	0	0	1
Total germination:						
a	15	12	11	10	10	10
b	6	21	22	10	10	19
c	11	5	7	9	10	20
Average	10.7	12.7	13.3	10.3	10.0	16.3

[a] First trial was started on September 9, 1953, and the second trial on October 16, 1953. One hundred seeds were planted in each plot.

TABLE 5a

Height in centimeters of 7-day-old seedlings in the second trial

TREATMENT	SEEDLING NUMBER											AVERAGE
	1	2	3	4	5	6	7	8	9	10	11	
Unsprayed	5	3.6	4.2									4.3
600	3	3.1	3.8									3.3
700	2.6	3.9	3.7									3.4
800	2.5	1.7	2.5	2.6	1.6	1.1						2.0
900	1.8	3.0	1.9	1.5	1.1	1.2	0.9	1.0				1.6
1000	2.8	1.8	0.6	1.5	0.8	0.6	1.6	1.6	0.7	0.7	0.6	1.2

TABLE 6

Height in centimeters of barnyard grass or watergrass sprayed with 2,4-D at different stages of growth [a]

CULTURE	AGE IN DAYS	POT 1	POT 2	POT 3	POT 4	AVERAGE
I	35	50.75	67.00	62.25	62.50	60.62
	55	65.25	84.25	68.50	76.50	73.62
	72	80.75	88.00	80.00	83.50	83.06
II	55	56.50	66.00	—	—	61.25
	72	66.50	68.00	—	—	67.25
III	35	45.75	51.50	41.50	47.25	46.50
	55	68.50	60.00	67.25	58.75	63.62
	72	61.50	68.00	70.00	70.25	67.43
IV	55	66.25	61.50	66.25	65.25	64.81
	72	87.50	81.50	81.75	85.00	83.93
V	72	82.25	84.25	83.25	86.50	84.06

[a] Planted April 14, 1953; flowered June 2, 1953. Figures are averages of four measurements, except in culture II where only two measurements were made.

TABLE 7

Germination of Elon-elon seeds planted at different times after spraying of seedbed with 2,4-D

CULTUEE	DATE PLANTED	SEEDLING COUNTS AT DIFFERENT DATES			FINAL COUNT	PERCENTAGE GERMINATION AT FINAL COUNT	REMARKS
I	April 17, 1953	4/22/53	4/25/53				All seedlings
a		69	75		75	75	healthy and
b		63	73		73	73	normal
c		72	78		78	78	
d		65	70		70	70	
Average						74.0	
II	April 17, 1953		4/25/53	5/1/53			All seedlings
a		47	17	0	0	0	died from
b		39	6	0	0	0	complete in-
c		18	14	0	0	0	hibition of
d		35	7	0	0	0	root growth
Average						0	
III	April 24, 1953	4/29/53	5/1/53	5/4/53			Some seed-
a		39	45	42	36	36	lings normal;
b		27	31	29	23	23	others with
c		24	32	26	26	26	inhibited root
d		28	31	31	29	29	growth
Average						28.5	
IV	May 1, 1953						All seedlings
a		72	74	74	74	74	healthy and
b		70	76	76	76	76	normal
c		55	62	68	68	68	
d		68	76	76	76	76	
Average						73.50	

TABLE 8

Height in centimeters of Thailand rice sprayed with 2,4-D at different stages of growth

CULTURE NO.	AGE IN DAYS	POT 1		POT 2		POT 3		POT 4		AVERAGE
		a	b	a	b	a	b	a	b	
I [a]	42	49	39	44	42	48	52	47	42	45.4
	69	66	71	67	59	66	71	62	62	65.5
	98	93	92	84	89	103	85	94	93	91.6
II [b]	42	35	40	42	41	28	36	37	33	36.5
	69	50	51	53	63	44	55	62	54	53.9
	98	118	80	100	76	109	107	108	88	98.3
III [c]	42	43	43	42	44	46	48	49	48	45.4
	69	49	51	67	69	69	73	68	70	64.5
	98	85	85	69	85	71	76	99	87	82.1
IV [d]	42	34	49	37	46	43	44	49	47	43.6
	69	53	70	64	69	57	60	68	62	62.9
	98	89	87	72	82	84	99	81	89	85.4

[a] Untreated.
[b] Sprayed one month after planting.
[c] Sprayed two months after planting.
[d] Sprayed three months after planting.

TABLE 8a

Number of tillers of Thailand rice sprayed with 2,4-D at different stages of growth

CULTURE	AGE IN DAYS	POT 1		POT 2		POT 3		POT 4		AVERAGE
		a	b	a	b	a	b	a	b	
I	69	11	3	4	8	3	4	6	3	5.3
	83	8	3	3	8	3	4	6	3	4.8
	98	8	3	3	8	3	3	6	3	4.6
II	69	4	6	4	5	9	3	5	5	5.1
	83	4	6	4	5	7	3	5	5	4.9
	98	5	3	5	8	7	3	7	6	5.5
III	69	8	6	4	4	3	4	5	4	4.8
	83	8	6	4	4	3	4	5	4	4.8
	98	4	4	3	3	—	—	3	4	3.5
IV	69	4	5	3	5	7	4	3	6	4.6
	83	4	5	3	5	7	4	3	5	4.5
	98	4	5	3	5	3	6	3	5	4.3

TABLE 8b

Yield of grains of Thailand rice sprayed with 2,4-D at different stages of growth

CULTURE	NUMBER OF PANICLES	WEIGHT OF GRAINS	WEIGHT OF A PANICLE	WEIGHT OF STRAW
		grams	*grams*	*grams*
I				
a	10	14.7	1.47	13.2
b	10	13.3	1.33	12.5
c	10	12.0	1.20	12.1
d	9	10.7	1.18	14.1
Average	9.8	12.7	1.80	13.0
II				
a	9	10.6	1.17	12.0
b	8	11.1	1.38	13.4
c	10	10.0	1.00	13.0
d	9	9.9	1.10	14.3
Average	9.0	10.4	1.16	13.2
III				
a	6	6.4	1.06	5.8
b	7	7.3	1.04	9.8
c	7	7.2	1.02	7.5
d	—	—	—	—
Average	6.7	7.0	1.04	7.7
IV				
a	7	5.9	0.842	8.6
b	6	6.7	1.11	9.6
c	7	6.1	0.871	9.3
d	7	6.9	0.985	10.8
Average	6.8	6.40	0.95	9.6

Analysis of variance of grain weight

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	F-VALUE		
				Computed	Tabular	
					1%	5%
Total	14	111.30				
Treatment	3	100.34	33.45	33.58	6.22	3.59
Error	11	10.96	.996			

L.S.M.D. = 1.65

TABLE 9

Height in centimeters of Inintiw rice plants sprayed with 2,4-D at different stages of growth

CULTURE	AGE IN DAYS	POT 1		POT 2		POT 3		POT 4		AVERAGE
		a	b	a	b	a	b	a	b	
I	30	39	37	38	39	38	36	36	39	37.8
	60	60	62	58	58	54	59	59	62	59.0
II	30	28	29	33	26	22	31	—	—	28.1
	60	63	64	58	40	58	55	—	—	56.3
III	30	36	32	38	35	32	34	38	34	34.9
	60	69	61	65	77	68	68	66	71	68.1
IV	30	37	34	40	43	38	39	36	39	38.3
	60	52	48	40	59	46	64	62	77	56.0
V	30	41	39	33	37	40	39	42	41	39.0
	60	75	78	62	57	59	63	63	60	64.6
VI	60	59	58	60	64	55	60	68	47	58.9

TABLE 9a

Tiller counts of Inintiw rice plants sprayed with 2,4-D

CULTURE	AGE IN DAYS	POT 1		POT 2		POT 3		POT 4		AVERAGE
		a	b	a	b	a	b	a	b	
I	30	2	2	3	4	2	4	3	2	2.8
	60	5	7	7	6	8	6	5	7	6.4
II	30	2	1	2	1	1	1	—	—	1.3
	60	6	2	4	3	3	2	—	—	3.3
III	30	1	1	1	1	1	1	1	1	1.0
	60	7	2	2	6	4	6	3	5	4.4
IV	30	3	2	2	2	2	3	2	3	2.4
	60	3	4	3	3	2	3	3	2	2.9
V	30	4	3	3	2	3	3	—	—	3.0
	60	15	10	8	5	7	9	—	—	9.0
VI	60	7	10	9	6	8	6	12	2	7.5

TABLE 9b

Yields of grains and straw of Inintiw rice plants sprayed with 2,4-D

CULTURE	NUMBER OF GRAINS	WEIGHT OF PANICLES	WEIGHT OF A PANICLE	WEIGHT OF STRAW
		grams	*grams*	*grams*
I				
a	12	11.8	0.98	14.6
b	8	6.1	0.76	11.0
c	11	11.8	1.07	13.5
d	8	10.8	1.35	14.7
Average	9.8	10.1	1.04	13.5
II				
a	6	7.7	1.28	9.0
b	4	6.1	1.52	10.0
c	6	9.2	1.53	9.2
d	—	—	—	—
Average	5.3	7.7	1.44	9.4
III				
a	8	10.0	1.25	11.1
b	6	7.4	1.23	10.1
c	9	12.9	1.43	14.3
d	9	13.0	1.44	13.1
Average	8.0	10.8	1.34	12.2
IV				
a	9	10.0	1.11	12.0
b	9	11.8	1.31	13.2
c	10	13.9	1.39	14.3
d	10	12.4	1.24	12.8
Average	9.5	12.0	1.26	13.1
V				
a	11	6.7	0.60	14.5
b	12	11.1	0.92	13.6
c	10	10.8	1.08	12.7
d	—	—	—	—
Average	11.0	9.5	0.87	13.6
VI				
a	11	9.2	0.83	13.4
b	13	9.8	0.75	12.0
c	14	10.8	0.77	11.9
d	11	7.8	0.70	15.5
Average	12.3	9.4	0.76	13.2

Analysis of variance of grain yield

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	F-VALUE		
				Computed	Tabular	
					1%	5%
Total	21	112.20				
Treatment	5	39.06	7.81	1.71	4.44	2.85
Error	16	73.14	4.57			

TABLE 10

Height in centimeters of Thailand rice plants sprayed with different concentrations of 2,4-D

CULTURE	AGE IN DAYS	POT 1		POT 2		POT 3		POT 4		AVERAGE
		a	b	a	b	a	b	a	b	
I	30	38	37	46	44	35	38	35	40	39.1
	60	51	47	52	51	48	51	45	50	49.4
	90	67	66	80	63	65	85	60	64	68.8
II	30	33	46	37	43	45	42	40	43	41.1
	60	40	46	39	40	41	44	44	40	41.8
	90	78	94	64	83	74	74	66	70	75.4
III	30	40	29	43	44	40	40	39	32	38.4
	60	36	23	45	44	44	35	30	26	35.4
	90	81	67	96	81	75	66	71	50	73.4
IV	30	33	40	40	45	48	45	38	42	41.4
	60	26	10	30	27	38	20	38	34	27.9
	90	95	57	80	81	82	92	90	86	82.9
V	30	39	36	35	36	39	39	46	37	38.4
	60	40	39	38	40	42	45	49	40	41.6
	90	70	61	74	74	76	74	85	65	72.4
VI	30	35	44	48	40	44	44	40	39	41.8
	60	35	43	48	40	46	45	40	40	42.1
	90	74	69	79	70	78	67	60	65	70.3
VII	30	36	35	38	39	45	41	41	45	40.0
	60	36	35	39	29	35	30	23	32	32.4
	90	67	74	70	66	73	70	70	82	71.5

TABLE 10a

Number of tillers

CULTURE	AGE IN DAYS	POT 1		POT 2		POT 3		POT 4		AVERAGE
		a	b	a	b	a	b	a	b	
I	30	10	5	9	6	5	7	8	7	7.1
	60	18	10	11	9	11	17	14	13	12.9
	90	13	6	10	5	7	14	8	9	9.0
II	30	5	8	12	9	4	8	7	12	8.1
	60	4	6	12	10	5	11	11	12	8.9
	90	5	6	8	9	4	8	10	14	8.0
III	30	5	3	4	9	7	7	7	7	6.1
	60	4	2	8	5	6	5	6	7	5.4
	90	9	3	9	6	12	7	6	9	7.6
IV	30	6	8	7	12	13	13	9	10	9.8
	60	3	1	3	6	3	9	6	6	4.6
	90	5	3	5	6	8	17	4	5	6.6
V	30	7	9	7	7	7	9	12	7	8.1
	60	5	9	7	6	10	13	12	9	8.9
	90	8	6	8	6	8	10	8	6	7.5
VI	30	11	9	9	10	12	8	10	9	9.8
	60	11	9	9	10	8	9	8	6	8.6
	90	10	6	6	5	6	5	8	5	6.4
VII	30	5	6	7	7	10	9	11	7	7.8
	60	4	6	7	7	8	5	4	4	5.6
	90	5	10	9	7	10	6	6	5	7.3

TABLE 10b

Yields of grains and straw

CULTURE	WEIGHT OF GRAINS	NUMBER OF PANICLES	WEIGHT OF A PANICLE	WEIGHT OF STRAW
	grams		*grams*	*grams*
1	36.0	15	2.40	30.0
2	31.9	12	2.65	37.5
I 3	40.4	19	2.12	38.3
4	37.3	17	2.13	39.5
Average	36.40	15.8	2.32	36.3
1	34.0	15	2.26	36.0
2	33.2	14	2.37	34.8
II 3	34.3	17	2.01	40.0
4	35.2	15	2.34	25.5
Average	34.2	15.3	2.25	34.1
1	31.4	14	2.24	28.0
2	31.0	14	2.21	37.5
III 3	20.8	12	1.71	30.0
4	35.8	13	2.75	36.1
Average	29.8	13.3	2.23	32.90
1	19.8	8	2.47	32.3
2	22.3	9	2.47	21.0
IV 3	19.9	9	2.21	29.5
4	15.9	9	1.76	25.6
Average	19.5	8.8	2.23	27.10
1	26.5	13	2.03	30.5
2	28.3	15	1.88	32.4
V 3	31.3	15	2.08	33.0
4	28.5	14	2.03	31.9
Average	28.7	14.3	2.01	32.0
1	25.0	15	1.66	29.3
2	24.3	15	1.62	28.6
VI 3	26.2	14	1.87	30.0
4	17.3	13	1.33	22.9
Average	23.20	14.3	1.62	27.70
1	23.0	14	1.64	26.4
2	28.4	11	2.58	33.0
VII 3	22.9	12	1.90	24.3
4	19.9	11	1.80	22.7
Average	23.6	12.0	1.98	26.60

Analysis of variance of grain weight

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	F-VALUE		
				Computed	Tabular	
					1%	5%
Total	27	1,189.33				
Treatment	6	910.41	151.74	11.43	3.81	2.57
Error	21	278.92	13.28			

L.S.M.D. = 5.35

TABLE 11

Number of roots of sprayed and unsprayed rice plants growing in culture solution

CULTURE	DATE OF OBSERVATION									
	Sept. 3, 1953 (Original No.)		Sept. 10, 1953		Sept. 17, 1953		October 1, 1953			
							a		b	
	a	b	a	b	a	b	Dead	Living	Dead	Living
Sprayed:										
1	17	21	17	21	14	22	14	32	22	40
2	16	15	19	15	16	15	10	40	12	47
3	18	18	19	18	16	18	13	28	13	45
Unsprayed:										
1	15	14	24	19	37	30	—	59	—	50
2	25	15	40	22	69	37	—	105	—	57
3	23	17	30	25	53	69	—	73	—	76

TABLE 11a

Fresh weight of rice plants in grams

TREATMENT	REPLICATION			AVERAGE
	1	2	3	
	grams	*grams*	*grams*	
Unsprayed	14.4	19.8	14.5	16.2
Sprayed	4.9	2.5	7.7	5.0

TABLE 12

Height in centimeters of Elon-elon rice seedlings grown in soil sprayed with 2,4-D one week before planting

CULTURE	AGE IN DAYS	POT 1		POT 2		POT 3		POT 4		AVERAGE
		a	b	a	b	a	b	a	b	
I [a]	36	52	46	49	51	54	55	47	48	50.3
IIa [b]	36	44	39	38	35	37	42	37	—	38.9
IIb [c]	36	40	44	39	40	30	31	31	33	36.0
IIc [d]	36	32	39	38	36	33	35	39	31	35.4
IIIa [e]	36	48	49	40	40	38	37	41	43	42.0
IIIb [f]	36	42	42	38	40	36	36	39	36	38.6
IIIc [g]	36	36	32	33	34	35	38	33	34	34.4

[a] Control (untreated).
[b] Treated with 1,000 ppm. isopropyl ester of 2,4-D; 5 gallons/1000 sq. ft.
[c] " " 1,500 " " " " " " " " " "
[d] " " 2,000 " " " " " " " " " "
[e] " " 1,000 ppm. Weed B-Gone-; 5 gallons/1000 sq. ft.
[f] " " 1,500 " " " " " " " "
[g] " " 2,000 " " " " " " " "

TABLE 13

Number of barnyard grass or watergrass plants growing after different 2,4-D treatments

CULTURE	FIRST COUNT May 28, 1953	FINAL COUNT June 8, 1953
I		
1	2	10
2	8	13
3	13	14
4	20	19
Average	10.8	14.0
IIa		
1	8	9
2	7	10
3	8	9
4	11	14
Average	8.5	10.5
IIb		
1	13	12
2	12	16
3	9	10
4	10	10
Average	11.0	12.0
IIc		
1	5	6
2	4	9
3	4	10
4	0	5
Average	3.3	7.6
IIIa		
1	10	14
2	10	10
3	6	11
4	8	10
Average	8.5	11.3
IIIb		
1	2	2
2	7	8
3	12	5
4	0	2
Average	5.3	4.3
IIIc		
1	1	2
2	0	3
3	0	3
4	0	0
Average	0.3	2.0

TABLE 14

Height in centimeters of rice plants growing with barnyard grass or watergrass and sprayed with 2,4-D [a]

CULTURE	POT 1		POT 2		POT 3		POT 4		AVERAGE
	a	b	a	b	a	b	a	b	
I	70	67	66	63	64	60	67	66	65.4
II	66	61	64	72	65	72	63	61	65.5
III	59	59	59	60	68	62	54	60	60.1
IV	58	58	60	58	59	60	62	35	56.3
V	64	61	65	68	61	67	63	74	65.4
VI	66	65	66	72	80	87	69	66	71.4

[a] Height was taken one month after treatment.

TABLE 14a

Number of tillers one month after treatment

CULTURE	POT 1		POT 2		POT 3		POT 4		AVERAGE
	a	b	a	b	a	b	a	b	
I	7	8	6	6	6	6	7	12	7.3
II	10	6	7	9	9	10	5	4	7.5
III	2	3	2	2	4	4	7	5	3.6
IV	5	6	3	2	5	4	4	2	3.9
V	6	7	5	5	7	4	6	5	5.6
VI	8	6	6	10	17	7	5	4	7.9

TABLE 14b

Yield of grains

CULTURE		WEIGHT OF GRAINS	NUMBER OF PANICLES	WEIGHT OF PANICLE
		grams		*grams*
I	1	15.0	10	1.50
	2	16.4	9	1.82
	3	14.0	10	1.40
	4	16.0	10	1.60
	Average	15.4	9.8	1.58
II	1	13.0	9	1.44
	2	15.2	10	1.52
	3	13.4	9	1.48
	4	14.9	10	1.49
	Average	14.1	9.5	1.48
III	1	11.5	8	1.43
	2	13.2	9	1.46
	3	10.6	8	1.32
	4	13.4	9	1.47
	Average	12.2	8.5	1.42
IV	1	12.5	7	1.78
	2	13.5	9	1.50
	3	13.3	9	1.47
	4	12.6	8	1.57
	Average	13.0	8.3	1.58
V	1	13.4	9	1.48
	2	15.2	10	1.52
	3	14.7	9	1.63
	4	11.4	10	1.14
	Average	13.7	9.5	1.44

Analysis of variance of grain weight

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	F-VALUE		
				Computed	Tabular	
					1%	5%
Total	19	44.87				
Treatment	4	22.99	5.75	3.94	4.89	3.06
Error	15	21.88	1.46			

L.S.M.D = 1.81

TABLE 15

Number of weeds in lots of rice and weeds after spraying with 2,4-D

CULTURE	DATE OF OBSERVATION	POT 1	POT 2	POT 3	POT 4	AVERAGE
II	Aug. 10, 1953	45	45	45	45	45.0
	Aug. 31, 1953	45	44	45	45	44.8
III	Aug. 10, 1953	2	3	6	3	3.5
	Aug. 31, 1953	1	3	6	1	2.8
IV	Aug. 10, 1953	0	0	0	0	0
	Aug. 31, 1953	0	0	0	0	0
V	Aug. 10, 1953	12	9	7	13	10.3
	Aug. 31, 1953	12	8	7	11	9.5
VI	Aug. 10, 1953	18	17	13	12	15.0
	Aug. 31, 1953	18	20	16	13	16.8

TABLE 16

Number of weeds in sprayed and unsprayed lots of a typical rice field

LOT AND TREATMENT	BEFORE SPRAYING (July 1)	AFTER SPRAYING (July 11)
Sprayed:		
I	224	0
III	393	3
V	319	4
Unsprayed:		
II	740	100
IV	537	495
VI	450	340

TABLE 17

Yield of grains in kilograms of sprayed and unsprayed lots

TREATMENT	LOT NUMBER						AVERAGE
	I	II	III	IV	V	VI	
Sprayed	3.000		2.735		3.484		3.073
Unsprayed		3.236		3.500		4.570	3.769

Analysis of variance of grain weight

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	F-VALUE		
				Computed	Tabular	
					1%	5%
Total	5	2.01				
Treatment	1	0.730	0.730	2.28	21.20	7.71
Error	4	1.280	0.32			

INVESTMENT AND INCOME ON 132 COCONUT FARMS IN INDANG, CAVITE, IN 1952 [1]

L. S. Robertson [2] and N. B. Tablante

Sixty-five of the farmers were owner-operators, 24 were tenants, and 43 were part-owners. Owners-operators averaged 45 years of age, 3.7 grades of school, and 25 years of farming experience. Other farmers averaged younger and had less education and farming experience. The average size of family was approximately five and one-half persons. Owner-operated farms averaged 2 hectares, 1½ hectares being in coconuts. Tenant-operated and partly owned farms were larger and had approximately two and one-half hectares in coconuts. Owner-operators had fewer work animals and less equipment than tenants or part-owners. Coconuts with the intercrops grown, required an average of slightly more than 200 days of labor to a farm.

Owner-operators had an average capital of ₱3761. Their average farm receipts were ₱578; farm expenses, ₱112; net farm income, ₱308; labor income, ₱83; farm privileges, ₱192; labor earnings, ₱270; nonfarm income, ₱463; and amount available for family use, ₱1006. The various measures of income were distinctly low on partly owned farms and still lower on tenant farms. Incomes varied widely. Ten farmers each had minus labor earnings and 10 others each had more than ₱744. Size of farm was positively associated with labor earnings and with amount of money available for family living and was negatively associated with receipts from off-farm work. Yield of coconuts per hectare was definitely related to various measures of farm income, particularly in the owner-operated farms. Neither age nor education of operator showed anything more than an indication of possible slight positive relationship to farm returns.

In Indang, Cavite, in 1952, 64 owner-operators of coconut farms made an average farm income of ₱308. This was the amount above all farm operating expenses other than the value of the farmer's own labor and the interest on his capital. It did not include the value of privileges, such as palay, garden, fuel, livestock, and use of house, furnished by the farm.

Twenty-four tenant farmers in the same area had an average farm income about one-half as large as that of the owner operators, and 43 part-owners had an income about two-thirds as large.

The information given above and other information regarding variations in income and the conditions that influenced income were revealed in a study made by the Department of Agricultural Economics in the summer of 1953 in the barrios of Kaytambog, Tambo Culit, and Kayquit, Indang, Cavite. Financial records were obtained through personal visits to the 132 farms chosen to represent all coco-

[1] Central Experiment Station Contribution No. 1763. Prepared in the Department of Agricultural Economics. Acknowledgment is due to Dr. C. A. Bratton for his valuable suggestions, to Mr. Marcos M. Nuestro for conducting the field survey, to Mr. Domiciano E. Raymundo for editing and computing the data, and to the 132 farmers for supplying the necessary information.

[2] Visiting professor of agricultural economics.

nut farms similarly operated. The study adds to the background of available economic information useful to individual farmers attempting to increase efficiency of operation and to officials planning and administering public programs.

THE INDANG AREA

Indang is a rather typical coconut-growing municipality. It is located in the highland portion of the province of Cavite and is 67 kilometers southwest of Manila. One provincial road traverses the municipality. Rice and pineapple are the secondary sources of income.

RESULTS OF THE STUDY

Characteristics of the 132 farm operators

Age. The 65 owner-operators averaged 45 years of age, the 24 tenants 34 years, and the 43 part-owners 43 years. Only one-half of the owner-operators, but three-fifths of the part-owners and nine-tenths of the tenants, were younger than 46 years. One-eighth of the owner-operators were older than 61 years, but none of the tenants were older than 53 years. In all tenure groups, operators of larger farms were older, on the average, than operators of smaller farms.

Education. Owner-operators had completed an average of 3.7 grades of school, tenants an average of 2.9 grades, and part-owners an average of 2.6 grades. Amount of education and size of farm operated showed no consistent relationship in any of the tenure groups.

Farming experience. Owner-operators had operated farms nine years longer than tenants and four years longer than part-owners. The average size of farm tended to increase with the amount of farming experience, as shown below:

	Years Farmed		
	OWNER	TENANT	PART-OWNER
Hectares to a farm:			
0.2–1.5	22	10	18
2.0–2.5	25	14	19
2.6–7.0	35	21	23
Average	25	16	21

Size of family. The average size of family was about five and one-half persons.

	OWNER	TENANT	PART-OWNER
Operator	1.0	1.0	1.0
Wife	.7	1.0	.9
Sons	1.8	1.5	1.8
Daughters	1.4	1.3	1.3
Others	.5	.5	.5
Total	5.4	5.3	5.5

Characteristics of the 132 farms

Farm size, land use, and coconut production. Owner-operated farms averaged 2 hectares, tenant-operated farms 2.7 hectares, and partly owned farms, 3.0 hectares, 2 of which were tenant-operated. Most of the land was in coconuts; the average yield for all farms was 2669 coconuts per hectare. Part or all of the coconut land on most farms was intercropped with some other crop.

	OWNER	TENANT	PART-OWNER
Hectares to a farm:			
Coconuts	1.5	2.5	2.3
Orchard	.1	.1	0.1
Other land	.4	.1	0.6
Total	2.0	2.7	3.0
Production coconuts to a farm	4,012	7,458	6,423

Livestock. Operators in all the tenure groups had only few livestock. Owner-operators had fewer work stock than tenants and part-owners. However, the three tenure groups did not differ significantly in number of other kinds of livestock, as shown below:

	OWNER	TENANT	PART-OWNER
Carabaos	.1	.4	.4
Work cattle	.4	.3	.4
Horses	.1	.2	.2
Sows	.1	.2	.1
Pigs	1.4	2.0	1.7
Hens	5.1	5.1	4.7
Pullets	3.2	3.3	3.3
Roosters	1.5	1.7	1.4
Young chickens	14.3	13.5	12.4

Equipment. Part-owners and tenants tended to be better equipped than owner-operators. Part-owners had machinery and tools valued at an average of ₱161, tenants ₱91, and owners ₱34.

Most of the farms had two or more bolos and one or more harvest tools, garden tools, and carpenter tools. Only about one-half had plows, one-third had harrows, one-third had rakes, and one-third had shovels. Other tools or machines such as sleds, carts, and sprinklers were found on not more than one-tenth of the farms.

Labor force. Part-owners worked on their farms six months of the year, and owners and tenants a little more. Other members of the family together contributed about one-half as much labor as the operator.

	Months of Labor		
	OWNER	TENANT	PART-OWNER
Operator	6.5	6.4	6.0
Wife	1.6	1.7	1.8
Sons	1.7	1.6	1.7
Daughters	.6	(Less than 0.05)	.3

For hired labor during the year, owner-operators paid ₱24 in cash and crops worth ₱16; tenants, ₱36 in cash and crops worth ₱24; and part-owners, ₱35 in cash and crops worth ₱39.

Use of labor. Coconuts, with the intercrops grown, required an average of slightly more than 200 days of labor to a farm in each of the tenure groups. Plowing and cleaning constituted the largest item of labor. Rice, the principal interplanted crop, required a much larger proportion of the total labor on tenant-operated and partly owned farms than on owner-operated farms.

	Days Labor to a Farm		
	OWNER	TENANT	PART-OWNER
Coconuts and minor intercrops:			
Plowing and cleaning	163.4	114.7	94.2
Picking coconuts	5.4	7.5	4.2
Piling and husking coconuts	4.6	9.1	5.6
Hauling coconuts	1.3	5.6	2.9
Miscellaneous	20.0	10.9	18.5
Total	194.7	147.8	125.4
Interplanted rice:			
Clearing fields	4.8	19.2	27.4
Plowing and harrowing	6.8	19.7	29.6
Planting	2.9	4.8	5.6
Weeding	6.8	12.6	11.8
Harvesting, threshing, cleaning, drying	.9	1.0	2.3
Total	22.2	57.3	76.7
Grand Total	216.9	205.1	202.1

Farm practices. A definite plan of operation was reported as being followed by one-fifth of the owner-operators, two-fifths of the tenants, and three-fourths of the part-owners.

Farm records were being kept by 12 of the part-owners (27 per cent), one of the tenants (4 per cent), and none of the owner-operators.

The percentage of loans received from various kinds of lenders varied among the tenure groups, as shown below:

	OWNER	TENANT	PART-OWNER
Merchants	23	27	43
Relatives	75	36	41
Landlords	0	37	15
Others	2	0	1

Owner-operators obtained an average of 1.5 loans during the year, tenants 5.1, and part-owners 3.3.

Farmers in each of the three tenure groups harvested coconuts at average intervals of 3.5 or 3.6 months. Owner-operators had trees averaging 30 years of age, tenants 37 years, and part-owners

32 years. The most common spacing of coconut trees was 10 meters by 10 meters.

Financial results

Capital. Owner-operators had an average capital of ₱3761. This was about seven times as large as the capital of tenants and four times as high as the capital of part-owners. The owner-operators not only had land, which the tenants did not have, but also had houses averaging two or three times as good, judging by the values reported.

	OWNER	TENANT	PART-OWNER
Land	₱2,932	₱ 0	₱1,527
Dwelling	592	192	610
Other buildings	6	4	12
Work animals	59	95	107
Other livestock	130	162	163
Tools and equipment	34	91	97
Supplies	8	6	8
Total	₱3,761	₱550	₱2,524

Farm receipts. Gross receipts from the farm business averaged ₱578 for owner-operators, ₱343 for tenants, and ₱426 for part-owners. Crop sales accounted for 88 per cent of the receipts of the owner-operators, 74 per cent of the receipts of the tenants, and 96 per cent of the receipts of the part-owners. Livestock and livestock products made up about one-tenth of the receipts on owner-operators, ₱94 for tenants, and ₱115 for part-owners. The har-owned farms.

	OWNER	TENANT	PART-OWNER
Crops sold	₱506	₱260	₱402
Livestock and livestock products	60	67	83
Miscellaneous cash sales	2	0	6
Increase in inventory	10	16	35
Total	₱578	₱343	₱426

Sales of coconuts by the operators amounted to an average of ₱224 on the owner-operated farms, ₱160 on the tenant farms, and ₱200 on the partly owned farms. Credit for crop sales included the value of crops given to harvesters, which was also charged as labor costs in farm expenses.

Farm expenses. Cash farm expenses averaged ₱112 for owner-operators, ₱94 for tenants, and ₱115 for part-owners. The harvesters' share of crops and the value of the farm labor of members of the operator's family were other items included in the total expenses shown below. No charges were included for unpaid interest on the operator's farm capital nor for the value of the operator's own labor.

	OWNER	TENANT	PART-OWNER
Livestock bought	₱ 25	₱ 31	₱ 23
Buildings and tools bought	25	8	16
Man labor hired	24	36	36
Miscellaneous cash	38	19	40
Total cash	₱112	₱ 94	₱115
Harvesters' share of crops	16	22	39
Value of unpaid family labor	142	86	115
Total all expenses	₱270	₱202	₱269

Net farm income. The gross farm receipts of the operator exceeded his total farm expenses by ₱308 on the owner-operated farms, ₱151 on the tenant farms, and ₱213 on the partly owned farms. This net farm income is the amount that the farm earns to pay the operator for his own farm labor and for interest on the capital he has invested, in addition to the items furnished by the farm for family living.

Labor income and labor earnings. When the capital was assumed to be worth 6 per cent and this amount of interest was subtracted from the farm income, the operator's labor income that remained averaged ₱83 on the owner-operated farms, ₱118 on the tenant farms, and ₱62 on the partly owned farms. The labor income is the pay the operator gets for his own labor, in addition to farm privileges.

The value of farm privileges averaged ₱192 on the owner-operated farms, ₱142 on the tenant farms, and ₱253 on the partly owned farms, as shown below:

	OWNER	TENANT	PART-OWNER
Use of dwelling	₱ 58	₱ 25	₱ 55
Crops used	58	76	124
Livestock and livestock products used	32	14	23
Other products used	44	27	51
Total	₱192	₱142	₱253

The value of farm privileges plus the labor income gave average labor earnings of ₱276 for owner-operators, ₱260 for tenants, and ₱315 for part-owners. Labor earnings are the best measure of comparative profitableness of various farms when a large proportion of the total production is consumed at home.

Nonfarm income. Three-fifths of the owner-operators and part-owners and nearly nine-tenths of the tenants supplemented their farm earnings by working off the farm. On most of the farms other members of the family also had off-farm earnings which went to support the family.

	OWNER	TENANT	PART-OWNER
Operator	₱126	₱117	₱187
Other members of family	237	61	102
Total	₱363	₱178	₱289

Amount available for family use. The earnings actually available to the farm family for living expenses, education, investment, or other uses included the farm income, the value of the privileges furnished by the farm, the value of the off-farm earnings of the operator and other members of the family, and the value of unpaid family labor which was assumed as a cost in calculating the farm income. The total of these various items was ₱1006 for owner-operators, ₱557 for tenants, and ₱884 for part-owners. The amount available for family use is the best measure for comparing earnings of farm families with earnings of families in other occupations.

VARIATIONS IN INCOME

Some farms were much more profitable than other farms. For example, six of the owner-operators made labor earnings above ₱744, whereas nine others made less than zero. The variation for each tenure group is shown below:

	OWNER	TENANT	PART-OWNER
Less than zero	9	0	1
₱ 7 to ₱ 129	17	13	5
₱ 130 to ₱ 252	16	9	15
₱ 253 to ₱ 375	7	2	7
₱ 376 to ₱ 498	4	0	5
₱ 499 to ₱ 621	3	0	3
₱ 622 to ₱ 744	2	0	3
₱ 745 to ₱ 867	1	0	3
₱ 868 to ₱ 990	2	0	1
₱ 991 to ₱1,113	1	0	0
₱1,114 and over	2	0	0
Total	64	24	43

FACTORS AFFECTING FARM EARNINGS

Much of the variation in profitableness of farms was the result of a combination of so many factors that the influence of each could not be measured separately. Among these factors were the various practices used in crop production or in handling livestock. Luck had some influence, although previous studies have shown that farmers usually "make their own luck" to a large extent. The influence of a few factors on earnings is pointed out below.

Size of farm. Size of farm was not consistently related to labor income in any of the three tenure groups, but it appeared to affect labor earnings because the value of farm privileges tended to increase with increase in size of farm. There was a definite tendency for off-farm work to bring in more returns on small than on large farms. The amount available for family living tended to increase as the size of farm increased. This was mostly because of the larger capital earning interest and the greater value of privileges on the larger farms.

	Size of Farm		
	0.2-1.5 ha.	2.0-2.5 ha.	2.6-7.0 ha.
Number of farmers			
Owners	28	23	14
Tenants	7	8	9
Part-owners	9	10	24
Farm income			
Owners	₱110	₱ 486	₱ 414
Tenants	132	129	185
Part-owners	205	135	257
Labor income			
Owners	₱—9	₱ 238	₱ 13
Tenants	108	97	144
Part-owners	116	49	45
Value privileges			
Owners	₱122	₱ 212	₱ 302
Tenants	109	139	170
Part-owners	118	217	319
Operator's nonfarm income			
Owners	₱241	₱ 47	₱ 30
Tenants	157	126	79
Part-owners	249	262	133
Other nonfarm income			
Owners	₱222	₱ 287	₱ 188
Tenants	49	59	73
Part-owners	157	84	89
Amount available to family			
Owners	₱796	₱1,148	₱1,208
Tenants	499	516	639
Part-owners	796	793	954

Crop yield. Coconut yields ranged among farms from 500 to 7200 coconuts per hectare. Tenant-operated farms had yields about one-ninth higher than those of other farms, a difference which is of questionable statistical significance.

Yield of coconuts per hectare was definitely related to farm income and labor income in the three tenure groups and to labor earnings on the owner-operated and tenant farms. The higher yields, however, tended to be associated with larger capital so that the effects on income of yield and capital may be "confounded." The most consistent relation of yield to income was on owner-operated farms, as shown below:

	500-1,900	2,000-2,500	2,600-7,200
Number of farms	20	22	22
Average yield	1,302	2,139	3,472
Average capital (₱)	1,998	3,740	5,308
Farm income (₱)	112	311	566
Labor income (₱)	—8	86	247
Privileges (₱)	121	192	247
Labor earnings (₱)	113	278	494
Amount available for family (₱)	744	998	1,273

Age of operator. Among owner-operators and part-owners, but not among tenants, age was slightly related to farm income and to labor earnings. Age was not consistently related to other measures

of income. The association of operator's age and earnings is shown below for part-owners, among whom the relationship was strongest.

	AGE OF PART-OWNERS, YEARS		
	22-35	36-47	48-65
Number of farms	14	15	13
Average age	31	42	55
Average capital (₱)	2,458	2,839	2,734
Farm income (₱)	155	177	308
Labor income (₱)	17	7	122
Privileges (₱)	250	272	255
Labor earnings (₱)	267	280	387
Amount for family (₱)	966	872	878

Education of operator. No significant relationship was evident between amount of education and various measures of earnings although the figures indicated the possibility of a positive association. With the comparatively few records involved, the influence of education could have been counteracted by the influence of accidental factors.

OUTSTANDING VARIETIES AND FORMS OF PUMMELO, CITRUS GRANDIS (LINN.) OSBECK, IN SOME TOWNS OF LAGUNA [1]

DOMINADOR T. CAIYOD AND L. G. GONZALEZ

WITH ONE TEXT FIGURE

Five varieties of pummelo were compared detailedly as to their fruit characteristics. No significant differences were observed in number and weight of seeds. Based on the findings of three judges, the pummelos may be ranked as follows in eating quality: Pink Marsh, first; Exconde Pink, second; Sunwui-lak, third; Siamese Pink, fourth; Vermilion, fifth; and Siam, the control, last. They have the following sugar-acid ratios: Pink Marsh, 5.85; Exconde Pink, 5.61; Vermilion, 4.27; Siamese Pink, 3.63; Siam, 3.31; and Sunwui-lak, 3.13.

In general, the trees of the five varieties studied were healthy and vigorous, indicating their adaptability to conditions in Laguna. They bore fruit regularly and were fairly resistant to pests and diseases. In the absence of other ranking varieties, any of the five would be better than Siam, which is now the most widely planted in Laguna.

At present only a few good varieties of pummelo are known. Some of them are not even named according to accepted rules of horticultural nomenclature, resulting in much ambiguity and synonymity. If these unclassified varieties could be gone over for their important pomological characters and their performance under certain conditions, they would be better known to the planters and distribution of planting materials would be facilitated. A still more worthwhile step would be an intensive search for desirable foundation stock among an unlimited number of chance seedlings now growing all over the country, presumably from seeds of pummelos of good eating quality.

Laguna, where the inhabitants are fruit-loving, would be a likely place in which to find pummelos of superior quality. This study was conducted from October, 1952, to February, 1954, (1) to discover outstanding varieties and forms of pummelo in as many towns in Laguna province as could be conveniently reached, (2) to compare the quality of the fruits selected, and (3) to describe the five chosen worthy forms preparatory to their being formally named as horticultural varieties. The survey included the towns of Santa Maria, Siniloan, Pakil, Paete, Luisiana, Calauan, Alaminos, Los Baños, and San Pablo City.

MATERIALS AND METHODS

The evaluation of the fruits was based on the decision of a panel of three judges and on the results of a chemical analysis for total

[1] Central Experiment Station Contribution No. 1764. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, March, 1954. Prepared in the Department of Agronomy under the direction of the junior author.

sugars and titratable acidity. The choice of the places where the survey was conducted was based on the abundance of pummelo trees grown and on favorable information obtained from persons expected to know, including agricultural agents, citrus growers, fruit dealers, and citrus enthusiasts.

Since it would be both inconvenient and uneconomical to transport the fruits collected from so many trees visited, preliminary selection was conducted, based on tree-to-tree tasting. Sampling was done on the spot; samples considered inferior to the Siam variety were discarded. The selected trees were indexed and recorded. Five representative samples from each were gathered, marked, wrapped, packed in boxes, and brought to the College for pomological study and chemical analysis.

At the College, the samples were tasted by a panel of three. The best 10 forms were scored 1 to 10, depending on the rating given by each judge. The five forms with the highest total points were considered as the final selection.

The six varieties, including Siam, were analyzed [2] for determination of pulp-juice ratio, titratable acidity, and sugar content.[3] The original plan included the determination of pH value, but this was discontinued [4] on the advice of Professor Villanueva.

RESULTS AND DISCUSSION

Field observation. Of the different varieties and forms studied, Siam, the most widely grown in commercial orchards, seemed to be the most susceptible to attacks of diseases and pests. On the other hand, Exconde Pink, a tree about seventeen years old, showed no sign of infection by diseases or infestation by pests although it was growing side by side with Siam. Pink Marsh, a medium-sized tree, did not appear as vigorous as Exconde Pink. Its resistance to pests and diseases could not be determined because it was sprayed with insecticide and painted with fungicide regularly. Sunwui-lak was fairly vegetative and was a very good bearer. Its fruit had the tendency to stay greenish up to maturity. Siamese Pink was the largest and the most vegetative. Its fruiting was regular and the fruits were markedly uniform in size and shape. Vermilion was the most prolific. Its fruiting was so heavy that the branches broke unless they were supported. Hardly any sign of pests and diseases was detected. Its main defect was the apparent tendency of the fruits to fall in a strong wind.

Quantitative and qualitative evaluation. Out of 60 trees examined, fruit samples from 10 trees were brought to the College for panel judging and for a study of their important fruit characters.

[2] Chemical analysis of the fruits was done under the direction of Professor Leopoldo Villanueva of the Department of Agricultural Chemistry.

[3] After AOAC, "Methods of Analyses of the Association of Agricultural Chemists," 1945, 6th edition.

[4] There was no pH meter operating in the College when the experiment was conducted. The colorimetric method is not accurate enough to be useful.

The selected varieties were Exconde Pink, Siamese Pink, Pink Marsh, Sunwui-lak, and Vermilion, formerly called Castillo. Considering taste as the most important character, Pink Marsh and Exconde Pink ranked first and second best with hardly any perceptible difference between them (table 1). Their total points were 29 and 28, respectively, and their computed sugar-acid ratios, 5.85 and 5.61 (table 1a). The two tests thus showed perfect agreement. The other varieties in the order of choice were Sunwui-lak with 23 points, Siamese Pink with 22 points, Vermilion with 17 points, and Siam, or the control, with 14 points. For the computed sugar and acid ratio, Sunwui-lak had 3.13, Siamese Pink, 3.63, Vermilion, 4.27, and Siam, 3.31 (tables 9 and 10). The values obtained in the two tests for the remaining four varieties were thus not in agreement. Inclusion in the discussion of other important characters, such as texture, color of flesh, pulp-juice ratio, and susceptibility to diseases and pests, would further change the rank of the varieties, depending on which character would be given priority. One thing is clear, however: in the opinion of most of those who tasted the samples, Siam ranked lowest among the varieties compared.

Analysis of variance values obtained for the different characters studied show significant variations among the varieties in the weight of the whole fruit, thickness of rind, weight of rind, weight of rag, percentage of edible portion, total reducing sugars, and titratable acidity. No significant difference was obtained in the number and weight of seeds.

In weight of fruit, Siamese Pink led the rest with a mean of 1346.56 grams (table 2). Among the varieties Pink Marsh, Exconde Pink, Siam, and Sunwui-lak, no significant differences were found. Vermilion proved to be the smallest.

Siam had the thinnest rind, followed by Exconde Pink, Vermilion, Pink Marsh, and Sunwui-lak; Siamese Pink had the thickest rind (table 3). In weight of rind the arrangement was altered, with Vermilion having the lightest rind, followed by Exconde Pink, Pink Marsh, Sunwui-lak, and Siam; Siamese Pink had the heaviest rind (table 4). Not much importance can be attached to the thickness and weight of rind, except perhaps in computing for the percentage of edible portion.

Vermilion had the least weight of rag, and Pink Marsh the greatest (table 5). More important than weight, however, is the ease with which the rag can be peeled. On this basis, Pink Marsh led them all.

In percentage of edible portion, Exconde Pink, Vermilion, and Pink Marsh were about the same (table 8). The next group included Siam, Sunwui-lak, and Siamese Pink.

Based on their pulp-juice ratios (table 11), Siam, Siamese Pink, and Vermilion were the juicy forms. Most people object to juicy pummelos like Siam because the juice drips from the fingers when the fruits are eaten. The driest form was Sunwui-lak. The juici-

ness of Exconde Pink and Pink Marsh was just right, in the opinion of the members of the panel.

All the six varieties were found to be seedy (tables 6 and 7).

Pomological descriptions of outstanding forms found. Siam pummelo was introduced from Siam. It is pyriform, medium to large, with thin rind and pearly-white flesh. It is very juicy and soft-textured with a sweet subacid flavor. It has a sugar content of 621.07 mg. per 100 ml. of pure juice and an acid content of 172.05 ml. N/10 NaOH per 100 ml. of pure juice. The tree is fairly productive under local conditions. Its principal defect is its high susceptibility to citrus canker. The variety has produced fruits better in quality and appearance at lower altitudes.

The parent tree of Exconde Pink was propagated from seeds by Mr. Gil Exconde of San Pablo. The fruit is reniform, medium to large, with a yellow-orange rind when fully mature. The cottonlike tissue underneath the skin is pale pink. The flesh is medium juicy, light pearly pink, and slightly brittle in texture; it easily separates from the envelope and has a peculiar, sweet, pleasant flavor. It has a sugar content of 403.72 mg. per 100 ml. of pure juice and has an acid content of 72.0 ml. N/10 NaOH per 100 ml. of pure juice. The seeds are large and few. The tree is vigorous, is a regular and excellent bearer, and is quite resistant to citrus canker.

Siamese Pink is a cross between the Siam and the Pink variety. The fruit is medium to large and is long oval. It has a medium-thick rind and is pinkish underneath. Its flesh, light pink, easily separates; it is soft-textured, of sweet, subacid flavor, very juicy, and of long keeping quality. Its sugar content is 492.72 mg. per 100 ml. pure juice, and its acid content is 135.66 ml. N/10 NaOH per 100 ml. of pure juice. The tree is fairly large, with long and upright branches. It is productive, is a regular bearer, and is resistant to canker.

Pink Marsh is a hybrid between the Pink pummelo and the Marsh grapefruit (*C. paradisi* Macf.). The fruit is medium to large, orbiculate, with yellowish-orange rind, and pinkish at the apex when fully mature. The cottonlike tissue is light pink. The flesh is medium juicy and easily separated from the envelope. The vesicles are slightly brittle and of a pale pink hue, with a peculiar, sweet, delicious flavor. There is a very slight trace of subacid after taste. It has a sugar content of 467.79 mg. per 100 ml. pure juice and an acid content of 79.93 ml. N/10 NaOH per 100 ml. pure juice. The seeds are large and few. The tree is vigorous, is a regular and excellent bearer, and is quite resistant to canker.

Sunwui-lak is an introduced Chinese variety, valuable because of its delicious flavor. The fruit is medium to large, ovate, with a greenish rind even when fully mature. The flesh is juicy, soft-textured, and almost colorless; it easily separates from the envelope and has a subacid, pleasant flavor. The seeds are small and numerous. Its sugar content is 404.32 mg. per 100 ml. pure juice; and its

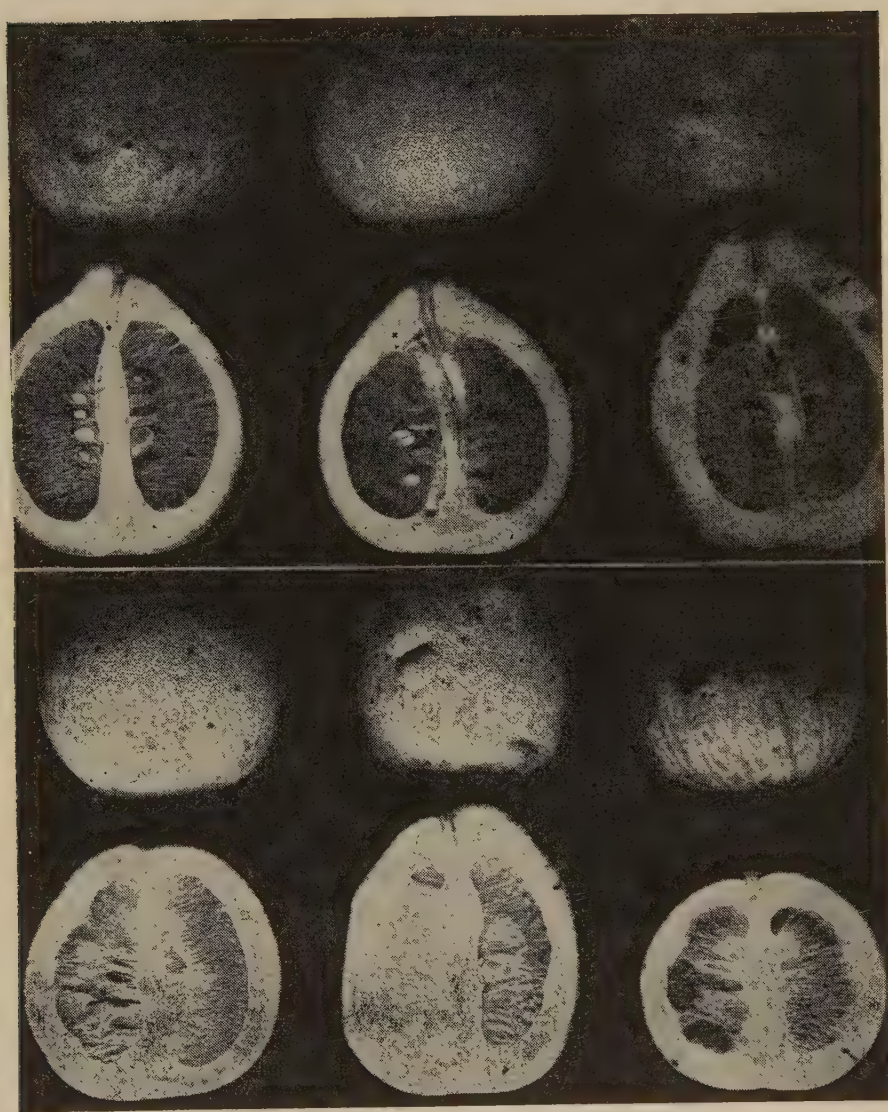

Fig. 1.—Shapes and longitudinal cross sections of some of the outstanding varieties of pummelo in Laguna. Upper panel, left to right: Siam, Exconde Pink, and Siamese Pink; lower panel: Pink Marsh, Sunwui-lak, and Vermilion. (*Photographed by the Photographic Division*).

acid content is 129.11 ml. N/10 NaOH per 100 ml. pure juice. The tree is vigorous, is a regular and good bearer, and is quite resistant to canker.

The fruit of Vermilion is small to medium, oblate, with a yellowish rind when fully mature. The cottonlike tissue is pink. The flesh is very juicy and soft-textured, with a sweet subacid flavor. It is also bright red in color, hence the name "Vermilion." It has a sugar content of 583.04 mg. per 100 ml. pure juice and an acid content of 136.42 ml. N/10 NaOH per 100 ml. pure juice.

TABLE 1

Owner and location in Laguna of 10 selected varieties and forms of pummelo

TREE NO.	VARIETY AND OWNER	LOCATION	RANK (panel)	SUGAR-ACID RATIO
I	Siam Exconde Citrus Farm	Lamot, Calauang	6th	3.61:1
II	Exconde Pink Exconde Citrus Farm	" "	2nd	5.61:1
III	Siamese Pink Economic Garden	Los Baños	4th	3.63:1
IV	Pink Marsh Economic Garden	" "	1st	5.85:1
V	Sunwui-lak Dr. Valeriano Calma	College	3rd	3.13:1
VI	Vermilion (Castillo) Exconde Citrus Farm	Lamot, Calauang	5th	4.27:1
VII	Pink Provincial Nursery	Calauang	7th	
VIII	Paete Pink Mr. Felix Cagahastian	Paete	10th	
IX	Pakil–1 Mr. Pedro Villarin	Pakil	8th	
X	Pakil–2 Mr. Pedro Villarin	"	9th	

TABLE 1a

Results of panel test on the taste of 10 outstanding forms of pummelo

VARIETY	PLACING BY PANEL						TOTAL POINTS
	X		Y		Z		
	Rank	Points (1-10)	Rank	Points (1-10)	Rank	Points (1-10)	
Siam	6	5	6	5	5	4	14
Exconde Pink	2	9	1	10	2	9	28
Siamese Pink	4	7	4	7	3	8	22
Pink Marsh	1	10	2	9	1	10	29
Sunwui-lak	3	8	3	8	4	7	23
Vermilion (Castillo)	5	6	5	6	6	5	17
Pink	8	3	7	4	8	3	10
Paete Pink	7	4	8	3	7	4	11
Pakil–1	9	2	9	2	9	2	6
Pakil–2	10	1	10	1	10	1	3

TABLE 2

Weight of the whole fruit in grams

FRUIT NO.	NUMBER OF TREE										TOTAL	MEAN
	I	II	III	IV	V	VI	VII	VIII	IX	X		
1	1210.5	921.3	1504.0	930.6	1134.9	961.2	880.2	825.2	862.2	992.5	10222.6	1022.3
2	1031.1	1129.5	1342.5	1205.5	931.3	953.2	872.0	962.2	683.6	967.2	10078.1	1007.8
3	874.0	1257.2	1272.1	1237.2	1213.5	727.4	1095.4	872.8	594.2	965.0	10108.8	1010.9
4	1121.8	928.7	1388.2	986.5	940.1	982.5	765.8	836.5	825.8	1012.5	19888.4	998.8
5	989.8	1021.5	1226.0	1120.2	943.5	878.6	685.5	953.8	944.2	984.7	9747.8	974.7
Total	5227.2	5258.2	6732.8	5480.0	5163.3	4502.9	4298.9	4450.5	4010.0	4921.9	50045.7	
Mean	1045.44	1051.64	1346.56	1096.00	1032.68	900.58	859.78	890.10	802.00	984.38		

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Trees	9	1,080,908.19	120,100.91	8.1566	2.12	2.88
Fruits	40	588,977.75	14,724.44			
Total	49	1,669,885.94				

L.S.M.D. = 188.30

TABLE 3

Thickness of rind in centimeters

FRUIT NO.	NUMBER OF TREE										TOTAL	MEAN
	I	II	III	IV	V	VI	VII	VIII	IX	X		
1	1.50	1.45	2.00	1.50	1.75	1.25	1.75	1.50	1.50	2.10	16.30	1.63
2	1.50	1.45	2.00	1.50	1.50	1.40	1.75	1.75	1.80	2.00	16.65	1.67
3	1.25	1.50	1.75	1.40	1.80	1.60	2.00	1.65	1.70	1.70	16.35	1.64
4	1.25	1.40	1.80	1.70	1.75	1.60	1.80	1.50	2.00	1.50	16.30	1.63
5	1.40	1.50	1.80	1.70	1.50	1.80	1.50	1.50	1.60	2.20	16.50	1.65
Total	6.90	7.30	9.35	7.80	8.30	7.65	8.80	7.90	8.60	9.50	(82.10)	
Mean	1.38	1.46	1.87	1.56	1.66	1.53	1.76	1.58	1.72	1.90		

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Trees	9	1.319	0.1466	5.18	2.12	2.88
Fruits	40	1.133	0.0283			
Total	49	2.452				

L.S.M.D. = 0.215

TABLE 4

Weight of rag in grams

FRUIT NO.	NUMBER OF TREE										TOTAL	MEAN
	I	II	III	IV	V	VI	VII	VIII	IX	X		
1	463.5	280.8	687.5	297.2	526.2	352.5	343.2	308.4	369.5	395.2	4024.0	403.4
2	421.7	379.5	592.0	429.0	441.8	364.8	340.4	354.0	227.8	347.2	3898.2	389.8
3	330.2	482.2	564.3	371.8	554.4	268.0	469.7	295.8	218.2	320.4	3875.0	387.5
4	452.6	320.5	579.2	364.4	419.7	390.2	311.3	238.9	397.8	434.6	3909.2	390.9
5	437.5	363.0	565.8	432.2	392.8	287.8	292.7	321.8	412.7	458.5	3964.8	396.5
Total	2105.5	1826.0	2988.8	1894.6	2334.9	1663.3	1757.3	1518.9	1626.0	1955.9	19671.2	
Mean	421.1	365.2	597.8	378.9	467.0	332.7	351.5	303.8	303.8	325.2	391.3	

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Trees	9	335,427.22	37,269.69	9.1329	2.12	2.88
Fruits	40	163,233.23	4,080.83			
Total	49	498,660.45				

L.S.M.D. = 83.43

TABLE 5

Weight of rind in grams

FRUIT NO.	NUMBER OF TREE										TOTAL	MEAN
	I	II	III	IV	V	VI	VII	VIII	IX	X		
1	97.8	86.5	120.7	136.5	93.5	78.8	80.2	79.1	83.3	134.6	991.0	99.10
2	99.0	103.6	116.5	101.2	87.2	82.6	79.1	73.7	106.2	137.1	996.2	99.62
3	85.7	121.5	104.8	117.5	97.4	79.8	92.5	81.0	87.3	143.9	1011.4	101.14
4	89.2	92.2	98.5	123.7	84.9	85.5	76.2	95.2	93.8	127.4	966.6	96.66
5	93.6	98.3	100.2	98.8	97.2	77.3	74.4	97.2	90.8	99.5	927.8	92.78
Total	465.3	502.1	540.7	577.7	460.2	404.0	402.4	436.7	461.4	642.5	4893.0	
Mean	93.0	100.4	108.1	115.5	92.0	80.8	80.5	87.3	92.3	128.5		

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Trees	9	10,777.26	1,197.47	10.889	2.12	2.88
Fruits	40	4,398.72	109.97			
Total	49	15,175.98				

L.S.M.D. = 15.68

TABLE 6

Number of seeds

FRUIT NO.	NUMBER OF TREE										MEAN	TOTAL
	I	II	III	IV	V	VI	VII	VIII	IX	X		
1	95	63	130	72	36	79	108	77	53	131	844	84.4
2	72	84	111	107	82	76	78	61	80	104	855	85.5
3	60	88	122	66	70	93	113	59	56	77	804	80.4
4	102	79	70	74	57	81	61	50	95	98	777	77.7
5	92	69	94	114	93	63	55	92	79	60	811	81.1
Total	421	383	527	433	348	392	415	399	363	470	(4091)	
Mean	84.2	76.6	105.4	86.6	69.6	78.4	83.0	67.8	72.6	94.0		

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Trees	9	6,020.58	668.95	1.6379	2.12	2.88
Fruits	40	16,336.80	408.42			
Total	49	22,357.38				

TABLE 7

Weight of seeds in grams

FRUIT NO.	NUMBER OF TREE										MEAN	TOTAL
	I	II	III	IV	V	VI	VII	VIII	IX	X		
1	39.4	28.5	47.0	30.3	12.5	25.2	47.5	33.0	21.2	48.4	333.0	33.30
2	28.8	37.8	39.9	44.9	28.7	24.3	33.2	26.2	32.5	39.4	335.7	33.57
3	23.5	36.6	43.9	27.7	24.5	40.6	49.7	25.3	22.4	32.7	326.9	32.69
4	42.8	34.7	24.2	21.0	23.4	25.9	26.8	21.5	38.0	39.2	307.5	30.75
5	36.8	30.4	33.8	47.8	32.5	30.1	24.2	39.5	31.6	24.0	330.7	33.07
Total	171.3	168.0	188.8	181.7	121.6	146.1	181.4	145.5	145.7	183.7	1633.8	
Mean	34.3	33.60	37.76	36.34	24.32	29.22	36.28	29.10	29.14	36.74		

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Fruits	9	895.99	99.55	1.48	2.12	2.88
Trees	40	2,682.58	67.06			
Total	49	3,578.57				

TABLE 8

Percentage of edible portion

FRUIT NO.	NUMBER OF TREE										TOTAL	MEAN
	I	II	III	IV	V	VI	VII	VIII	IX	X		
1	50.3	57.0	43.1	50.1	44.2	52.5	46.5	48.9	45.0	41.7	479.3	47.93
2	46.7	53.8	44.2	52.2	49.8	50.5	48.0	51.8	46.4	45.8	489.2	48.92
3	49.7	49.0	43.9	54.6	44.3	46.6	44.1	53.9	44.8	48.5	479.4	47.94
4	47.8	51.7	42.2	47.4	43.8	48.9	45.9	52.7	42.8	41.6	464.8	46.48
5	42.6	51.8	42.9	48.3	44.6	55.0	42.9	51.9	43.3	40.9	464.2	46.42
Total	237.1	263.3	216.3	252.6	226.7	253.5	227.4	259.2	222.3	218.5	2376.9	
Mean	47.4	52.7	43.3	50.5	45.3	50.7	45.5	51.8	44.5	43.7		

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Trees	9	576.09	64.01	9.9087	2.12	2.88
Fruits	40	258.21	6.46			
Total	49	834.30				

L.S.M.D. = 3.21

TABLE 9

Acidity expressed in milliliters of N/10 NaOH per 100 ml. of undiluted juice

NUMBER OF TRIAL	NUMBER OF FRUIT						TOTAL
	I	II	III	IV	V	VI	
1	198.88	71.20	144.40	84.80	123.60	136.00	758.88
2	162.67	71.20	132.80	80.00	132.53	137.77	716.97
3	154.60	73.60	129.80	75.00	131.20	135.60	699.80
Total	516.50	216.00	407.00	239.80	387.33	409.37	(2175.65)
Mean	172.05	72.00	135.67	79.93	129.11	136.46	

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Trees	5	21,639.79	4,327.96	38.9836	3.11	5.06
Fruit	12	1,332.20	111.02			
Total	17	22,971.99				

L.S.M.D. = 18.15

TABLE 10

Amount of total reducing sugar (as invert) in milligrams per 100 ml. of undiluted juice

NUMBER OF TRIAL	NUMBER OF FRUIT						TOTAL
	I	II	III	IV	V	VI	
1	615.33	371.95	471.95	465.92	425.79	586.85	2937.79
2	629.95	368.91	489.99	478.14	383.77	601.37	2952.13
3	617.94	474.25	516.23	459.31	403.41	560.89	3032.03
Total	1863.22	1215.11	1478.17	1403.37	1212.97	1749.11	(8921.95)
Mean	621.07	405.04	492.72	467.79	404.32	583.04	

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Trees	5	122,110.57	24,422.114	28.7002	3.11	5.06
Fruit	12	10,211.26	850.938			
Total	17	132,321.83				

L.S.M.D. = 50.110

TABLE 11

Pulp-juice ratio

	VARIETY NUMBER					
	I Siam	II Exconde Pink	III Siamese Pink	IV Pink Marsh	V Sunwui-lak	VI Vermilion
Juice	76.00	43.28	69.60	56.32	79.90	69.60
Pulp	36.30	38.95	39.50	42.75	64.10	95.50
Ratio	1:2.09	1:1.11	1:1.76	1:1.32	1:1.25	1:2.73

THE DIGESTIBILITY OF BARIT (LEERSIA HEXANDRA) AND BUNGALON (ECHINOCHLOA STAGNINA) BY HORSES AND SHEEP [1]

J. K. Loosli,[2] Valente Villegas, and L. A. Ynalvez [3]

On the average, the protein, fiber, and nitrogen-free extract of barit were slightly more digestible than those of bungalon. The fiber and N.F.E. of barit were more highly digested by sheep than by horses; no other differences were noted between the species. On a fresh basis, barit contained twice as much dry matter, digestible protein, and T.D.N. as bungalon. On a moisture-free basis, barit was only slightly higher in digestible protein and total digestible nutrients.

The two grasses most widely used as horse feed in the Philippines are barit (*Leersia hexandra* Sw.) and bungalon (*Echinochloa stagnina* Beauv.). Whenever available, they are preferred to other grasses because they are very palatable and are believed by some horsemen to impart unusual stamina to horses.

Tests were conducted to determine the digestibility of barit and bungalon by horses and sheep.

EXPERIMENTAL PROCEDURE

Three grade Shropshire sheep and two grade Arabian horses were used in the study. The technique of handling the sheep was similar to that described by Loosli *et al.*[4] The horses were kept in box stalls. An attendant watched the animals at all times during the 10-day collection periods so that the feces could be collected as soon as they were voided, thus preventing contamination with urine or other foreign matter. The daily collection of feces was weighed. Five per cent aliquots were taken, dried under infrared lamps, and sealed in Mason jars. The horses were watered twice a day. One-third of the daily feed was given at 8:00 a.m., and the remaining two-thirds at 3:30 p.m.

RESULTS AND DISCUSSION

It is evident from table 1 that the sheep and horses digested the forages to approximately the same extent for most of the nutrients. However, the mean coefficients for crude fiber and nitrogen-free extract of barit were higher for sheep than for horses. With bungalon there was no uniform difference between sheep and horses. On the

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[1] Central Experiment Station Contribution No. 1765.

[2] Visiting professor of animal husbandry from Cornell University.

[3] The authors gratefully acknowledge assistance of A. Palacpac and S. E. Claud in collecting and preparing the samples for analyses and of Lolita Austria and Epifania Cruz in making the chemical analyses.

[4] J. K. Loosli, V. Villegas, G. V. Garcia, and L. A. Ynalvez, *Philippine Agriculturist*, 37: 520 (1954).

average, the nutrients of barit were more digestible than those of bungalon. The authors believe that the values obtained can be applied to the forages as they are usually fed. It should be remembered, however, that the stage of maturity greatly affects the digestibility of a forage [5] and that these coefficients cannot be applied to forages of less or greater maturity than the samples studied.

For ease and accuracy in comparison, the average values for composition and digestible nutrient content of the forages were calculated on a moisture-free basis (table 2). The barit was almost twice as high in dry matter as the bungalon because there was a considerable delay between the time it was harvested and when it was analyzed for moisture and fed to the animals. The barit was delivered to the College every morning by a farmer who lived nearby, whereas the bungalon was cut in a field near the barn and fed to the animals within a few minutes. The dry-matter content of the barit is probably similar to that of the forages usually fed to horses since the handling procedure used was the same. It is interesting to note that the T.D.N. (total digestible nutrients) value of the barit was only about four per cent greater for the sheep than for the horses. The digestible protein of both grasses was the same for sheep and horses.

The barit was higher in digestible protein and total digestible nutrient content on a moisture-free basis than the bungalon. Thus, it appears that the sample of barit studied had a higher nutritive value. The barit was slightly higher in total protein content and lower in crude fiber, possibly indicating that it was somewhat less mature than the bungalon.

The grasses had not headed out. The barit had an average height of 50 centimeters and the bungalon, 80 centimeters. The stems of the bungalon appeared coarser than those of the barit. Unfortunately leaf-stem ratios were not determined.

Further studies should be made of the two grasses at various stages of maturity before one can conclude that barit is always a more nutritious grass than bungalon. The present data show that barit and bungalon are both good forages when they are harvested at a desirable and early stage of maturity. Villegas [6] reported an unreplicated test in which bungalon yielded an estimated rate of 81 metric tons of fresh forage in a year, compared with 30 metric tons for barit.

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[5] *Ibid.*

[6] V. Villegas, "Comparative Yields and Palatability of Barit, Bayakibok, Bulang, Bermuda Grass, Trigotrigohan and Culape for Soil Purposes," Proceedings Eighth Pacific Science Congress, Manila, 1954.

TABLE 1

Digestion coefficients for sheep and horses

ANIMAL	DIGESTION COEFFICIENTS				
	Organic matter	Crude protein	Ether extract	Crude fiber	N.F.E.
Barit:					
Sheep No. 194	68.2	68.4	13.2	71.6	69.0
" " 197	73.6	72.5	54.6	76.0	73.1
" " 226	65.7	61.6	34.6	70.0	64.9
Mean	69.2	67.5	25.3	72.5	69.0
Horses					
Ruby	60.0	67.4	34.5	58.3	61.3
Republika	63.1	70.6	35.7	64.4	61.8
Mean	61.6	69.0	35.1	61.4	61.8
All animals (Mean)	66.1	68.1	34.5	68.1	66.0
Bungalon:					
Sheep No. 194	53.9	32.2	79.6	61.9	55.3
" " 197	60.3	51.9	81.1	66.6	54.4
" " 226	54.1	72.9	80.7	59.0	44.7
Mean	56.1	52.3	80.5	62.5	51.8
Horses					
Ruby	53.3	54.3	70.4	56.6	49.2
Republika	61.9	45.1	13.1	64.8	62.9
Mean	57.6	49.7	41.8	60.7	56.0
All animals (Mean)	56.7	51.3	65.0	61.8	53.3

TABLE 2

Average composition and digestible nutrient content of the forages

ANIMAL	DRY MATTER	DIGESTIBLE PROTEIN	T.D.N.	PERCENTAGE COMPOSITION				
				Protein	Fat	Fiber	N.F.E.	Ash
	per cent	*per cent*	*per cent*					
Barit: [a]								
Sheep	34.2	1.7	20.2	2.5	0.8	10.6	15.0	5.3
Horses	34.2	1.7	19.4	2.5	0.8	10.6	15.0	5.3
Bungalon: [a]								
Sheep	19.3	0.7	10.0	1.3	0.4	6.5	8.8	2.3
Horses	19.3	0.7	10.0	1.3	0.4	6.5	8.8	2.3
Barit [b]	—	5.0	56.9	7.3	2.3	31.2	43.8	15.4
Bungalon [b]	—	3.5	51.8	6.9	2.2	33.6	45.5	11.8

[a] Fresh basis (as fed).
[b] Dry-matter basis (moisture-free).

EFFECT OF MONTH OF PLANTING ON THE GROWTH AND DEVELOPMENT OF KENAF (HIBISCUS CANNABINUS)[1]

JOSE C. DE LA CRUZ, JR.

WITH ONE TEXT FIGURE

In monthly plantings of kenaf at Los Baños from July, 1952, to June, 1953, the highest average yields of dry fiber and seeds were obtained from the April, March, and May plantings. The plantings did not differ significantly in tensile strength. The plantings in March, April, and May were significantly taller than those planted toward the short-day period. The lowest percentage of extraction was from the November planting, and the highest from the May, June, March, and April plantings.

The effect of the month of planting on the yield of high-quality fiber is one of the most important problems in the culture of kenaf (*Hibiscus cannabinus* Linn.)

According to David,[2] Dekker reported that in Java higher yields of fiber were obtained when the plants were allowed to attain maturity.

Crane and Acuña[3] recommended that kenaf for fiber be harvested during the flowering stage to obtain the best results as far as yield and separation of the fiber from the stem are concerned.

Crane, Acuña, and Alonso[4] concluded that for high yields of seeds per unit of land, planting in Cuba should be done in July or August by drilling in rows 20 or 24 inches apart with 2 or 3 inches between plants in the row. They added that planting for fiber can be done from the start of the rainy season until the middle of July, but it is preferable to plant as early in the period as possible. Regardless of time of planting during the rainy season, flowering of kenaf will not take place at 23 north latitude until September or October when the length of the daily light period is only 12½ hours.

Guanco[5] observed that May, the height of the dry season, was the best time for planting for fiber, followed by March, April, and February. For production of seeds March, April, and May were found to be the best months for planting.

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[1] Central Experiment Station Contribution No. 1766. Thesis presented for graduation, April, 1954, with the degree of Bachelor of Science in Agriculture. Prepared in the Department of Agronomy under the direction of Dr. Pedro A. David.

[2] P. A. David, *Philippine Agriculturist*, 32, 21 (1948).

[3] J. C. Crane and J. B. Acuña, *Jour. Amer. Soc. Agron.* 37, 969 (1945).

[4] J. C. Crane, J. B. Acuña, and R. E. Alonso, *Jour. Amer. Soc. Agron.*, 38, 45 (1946).

[5] Efrain C. Guanco, "A Comparative Study of the Growth and Development of Kenaf (*Hibiscus cannabinus* Linn.) Planted at Monthly Intervals." (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, 1953. Unpublished.)

Walker and Sierra [6] found that June planting in Cuba gave the highest yield of fiber and seeds.

To determine the effect of month of planting on the growth and development of kenaf, this study was conducted from July, 1952, to June, 1953, in the experimental plot and laboratory of the Fiber and Oil Division of the Department of Agronomy, Central Experiment Station.

MATERIALS AND METHODS

A fairly well-drained field of Lipa clay loam soil previously planted to corn was prepared and divided into 12 plots, each plot having an area of 25 square meters. One-foot paths were laid out between the plots. Each plot consisted of eight rows set 9 inches apart. The first four rows were for fiber production and the other four rows were for seeds. The seeds for fiber production were set 2 inches apart in the row, and those for seed production were set 4 inches apart. Each row represented a replication; thus, for each treatment there were four replications. The first plot was planted on July 29, 1952. Subsequent plantings were done on the 29th day of each succeeeding month, except the February planting which was done on the 28th. The last planting was on June 29, 1953.

The heights of 25 plants chosen at random from each replication were measured from the base to the tip. The weeds in-between the rows and around the plots were cut, but the plots themselves were not cultivated because the roots of the plants might be destroyed.

When they were in full bloom the plants were cut at the level of the ground, bundled, labeled, brought to the laboratory, and weighed. The bundles were submerged in a concrete tank filled with water; they were held in place with large stones. The water in the tank was changed every day. Retting was considered complete when the fibrous bast separated easily from the adhering pulp. The fibers were washed and dried in the sun.

The capsules were harvested when the first five or six lower ones on the stalks were dry. The stalks were cut, bundled, and dried separately in the sun. When the cut stalks had completely dried the seeds were threshed by hand. The capsules were broken from the stalks and were shaken. The seeds were winnowed and screened.

The breaking load of the fibers was determined with the Scott Tester IP-2 Tensilgraph machine using samples of single-fiber strands from the different plantings. Four trials were made from each planting. The tensile strength of the fibers expressed in breaking length was computed in accordance with the formula of Botkin, Shires, and Smith: [7]

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[6] J. E. Walker and M. Sierra, *USDA Cir.* 854 (1950).

[7] C. W. Botkin, C. B. Shires, and E. C. Smith, *New Mexico Exper. Sta. Bull.*, 300 (1950).

$$\text{Tensile strength (km.)} = \frac{\text{Breaking load} \times 1}{\text{Wt. of sample per cm.} \times 100{,}000}$$

Breaking load expressed in grams
Wt. per cm. expressed in grams
100,000 = cm. per kilometer.

RESULTS AND DISCUSSION

Control of pests[8] *and diseases.* On September 7, 1952, *Monolepta bifasciata* Hornst was found actively feeding on the young leaves of the July planting. The plot was sprayed with Gesarol (50 per cent DDT) mixed with a gallon of water. *Nisotra gemella* Erichson was also found feeding on the young leaves of the plants, but the infestation was not heavy. Subsequent sprayings were necessary to check the insect pests.

A fungous disease caused by *Phoma sabdariffae* Sacc.[9] was found lightly attacking the plants. No spraying was made to check the disease.

Yield of dry fiber. The lowest mean yield of dry fiber was obtained from the September 29 planting (table 1). This may be due to the rather early flowering of the plants on November 18, 1952, or about fifty-one days after planting (table 5). The mean height of the plants at the time of harvest was only only 57.30 centimeters (table 3); hence, the fibers were also short (fig.1).

The highest yield of dry fiber was obtained from the April 29 planting. These plants flowered on September 11, 1953, or 135 days after planting. At the time of harvest the plants had a mean height of 251.23 centimeters. The fibers produced from this planting were the longest (fig. 1).

The data in table 1 tend to show that kenaf planted toward the long-day period (January to July plantings) produced higher mean yields of fiber than those planted toward the short-day period (August to December plantings). The mean yields from the March 29 and April 29 plantings were significantly higher even at the 1 per cent level than that of any of the other plantings. It may be pointed out that the best months for planting kenaf in Los Baños for fiber production are March, April, and May when the kenaf plants, which are supposed to be short-day plants, will be subjected to longer days, resulting in longer periods of growth.

Yield of seeds. The taller plants generally produced more seeds than the shorter plants (table 2). The three plantings which gave the lowest yields of seeds were those in October, September, and November. The mean yields of seeds of the plantings in April, March, May, January, and June were significantly higher than those of the other plantings.

[8] All insects mentioned in this study were identified by Dr. Silverio M. Cendaña of the Department of Entomology.

[9] Identified by Dr. Faustino T. Orillo of the Department of Plant Pathology.

Fig. 1.—Lengths of kenaf fibers as influenced by the month of planting: I—July planting; II—August planting; III—September planting; IV—October planting; V—November planting; VI—December planting; VII—January planting; VIII—February planting; IX—March planting; X—April planting; XI—May planting; and XII—June planting. (*Photographed by Dr. Julian Banzon of the Photographic Division.*)

The later maturing and taller pants in general produced consistently more seeds than the early-maturing and shorter plants. For seed production, therefore, April, March, and May seem to be the best time for planting in Los Baños. However, the April, March, and May plantings yielded less than the corresponding plantings in the work of Guanco.[10] This might have been due to closer spacing in the present study, which resulted in the production of thinner plants.

Height of plants. The tallest plants were from the April 29 planting, whereas the shortest plants were from the November 29 planting (table 3). The tallest plants flowered in 135 days, and the shortest plants flowered in 53 days (table 5). The early flowering of the plants planted in November 29 may be attributed to the short days to which they were exposed. Those planted in April 29 flowered very much later because the days in summer are longer. The plants in the April 29 planting were significantly taller even at the 1 per cent level than those in any of the other plantings. In general, the plants planted during the long-day period were significantly taller than those planted during the short-day period.

Tensile strength. The fibers produced from plants planted in November 29 were weaker than those from other plantings (table 4). The fibers of the plants in the May 29 planting were apparently the strongest. The differences in tensile strength of the fibers, however, were not significant. Tensile strength, therefore, was not influenced by the time of planting. Walker and Sierra [11] also obtained insignificant results on the effect of planting date on the strength of the fibers.

Percentage extraction. The lowest percentage of extraction was from the November 29 planting, and the highest was from the May, June, March, and April plantings (table 6).

Weather data. The heaviest average rainfall was recorded in October, and the least was in April (table 7). January had the lowest mean temperature, and June had the highest. The mean relative air humidity was highest in August and lowest in April.

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[10] Guanco, *op. cit.*
[11] Walker and Sierra, *op. cit.*

TABLE 1

Yield of dry fiber in grams as influenced by the month of planting

MONTH OF PLANTING	REPLICATION				MEAN
	I	II	III	IV	
July 29, 1952	260.0	270.0	175.5	126.0	207.9
August 29	45.0	76.5	90.0	81.0	73.1
September 29	23.5	33.3	43.6	50.2	37.7
October 29	73.0	53.4	60.8	58.2	61.4
November 29	49.0	51.0	44.0	49.0	48.3
December 29	52.0	138.0	102.0	79.8	93.0
January 29, 1953	188.0	169.3	179.0	183.0	179.8
February 28	134.8	108.5	143.5	144.5	132.8
March 29	359.0	378.0	370.0	237.0	336.0
April 29	466.0	481.5	658.5	488.0	523.5
May 29	238.5	182.5	248.5	219.5	222.2
June 29	185.2	182.2	199.8	188.5	188.9
Mean	172.8	177.0	192.9	158.7	

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Plantings	11	870,553.66	79,141.24	47.913	2.09	2.84
Replications	3	7,136.08	2,378.69	1.440		
Error	33	54,508.51	1,651.77			
Total	47	932,198.25				

L.S.M.D. = 60.76 grams

TABLE 2

Yield of seeds in grams as influenced by the month of planting

MONTH OF PLANTING	REPLICATION				MEAN
	I	II	III	IV	
July 29, 1952	20.4	19.6	20.8	22.5	20.82
August 29	15.6	18.1	16.2	17.4	16.82
September 29	10.3	9.3	8.8	11.0	9.85
October 29	12.3	11.8	10.3	12.4	11.70
November 29	9.6	10.1	8.7	9.8	9.55
December 29	18.8	19.4	21.2	17.3	19.18
January 29, 1953	29.7	32.3	27.1	30.0	29.77
February 28	24.6	20.1	18.2	22.0	21.22
March 29	48.4	51.5	50.2	42.8	48.22
April 29	62.1	58.3	60.5	66.3	61.80
May 29	43.2	36.2	41.8	40.2	40.35
June 29	24.3	28.2	20.6	25.1	24.55
Mean	26.61	26.24	25.37	26.40	

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Plantings	11	11,655.354	1,059.577	190.674	2.09	2.84
Replications	3	10.734	3.578	0.643		
Error	33	183.371	5.557			
Total	47	11,849.459				

L.S.M.D. = 3.56 grams

TABLE 3

Height of kenaf plants in centimeters as influenced by the month of planting

MONTH OF PLANTING	REPLICATION				MEAN
	I	II	III	IV	
July 29, 1952	164.40	160.90	159.40	160.10	161.20
August 29	104.10	116.20	108.90	99.70	107.22
September 29	56.80	58.10	62.10	52.20	57.30
October 29	68.10	69.40	71.00	63.90	68.10
November 29	38.10	41.40	45.10	46.40	42.75
December 29	121.16	127.58	116.72	105.36	117.70
January 29, 1953	120.64	148.68	149.00	155.52	143.46
February 28	181.04	167.08	158.20	167.20	168.38
March 29	222.16	203.56	185.20	189.92	200.21
April 29	254.12	221.60	268.76	261.64	251.53
May 29	202.32	156.00	216.12	218.80	198.31
June 29	220.20	201.56	185.20	189.92	199.22
Mean	146.09	139.33	143.80	142.55	

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Plantings	11	188,685.779	17,153.526	85.119	2.09	2.84
Replications	3	285.936	95.312	0.472		
Error	33	6,650.256	201.522			
Total	47	195,621.971				

L.S.M.D. = 20.437 centimeters

TABLE 4

Tensile strength in kilometers of fiber as influenced by the month of planting

MONTH OF PLANTING	REPLICATION				MEAN
	I	II	III	IV	
July 29, 1952	36.25	15.83	40.33	45.00	34.35
August 29	42.50	31.75	32.50	32.50	34.81
September 29	22.50	36.00	28.00	32.50	29.75
October 29	26.25	36.25	32.75	25.00	30.06
November 29	12.50	28.75	20.00	36.00	24.31
December 29	23.33	38.75	27.66	35.00	31.18
January 29, 1953	33.83	26.66	35.12	32.50	32.02
February 28	20.83	35.00	38.50	37.50	32.96
March 29	27.50	42.50	26.50	32.50	32.25
April 29	33.75	41.66	29.00	27.50	32.97
May 29	75.00	39.37	48.33	43.33	51.51
June 29	37.00	34.50	81.00	34.50	46.75
Mean	32.60	33.91	36.64	34.48	

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Plantings	11	2,448.982	222.634	1.840	2.09	2.84
Replications	3	101.857	33.952	0.280	2.35	2.74
Error	33	3,992.790	120.993			
Total	47	6,543.629				

TABLE 5

Maturity and yield of fiber as influenced by the month of planting

MONTH OF PLANTING	DATE OF OPENING OF FIRST FLOWER	APPEARANCE OF FIRST FLOWER AFTER PLANTING	DATE OF HARVESTING	NUMBER OF DAYS FROM PLANTING TO HARVESTING	MEAN YIELD OF DRY FIBER
		days		*days*	*grams*
July 29, 1952	Oct. 9	72	Oct. 12	75	207.9
August 29	Nov. 8	71	Nov. 11	74	73.1
September 29	Nov. 18	51	Nov. 27	60	37.1
October 29	Dec. 15	47	Dec. 20	52	61.5
November 29	Jan. 20	53	Jan. 27	60	58.3
December 29	Feb. 8	41	Feb. 11	44	93.0
January 29, 1953	Mar. 8	38	Oct. 4	248	179.8
February 28	Aug. 19	172	Sept. 6	190	132.8
March 29	Sept. 10	165	Oct. 28	216	336.0
April 29	Sept. 11	135	Oct. 28	182	523.5
May 29	Sept. 22	116	Oct. 30	154	222.3
June 29	Sept. 28	91	Nov. 6	130	188.9

TABLE 6

Percentage of dry fiber as influenced by the month of planting

MONTH OF PLANTING	REPLICATION				MEAN
	I	II	III	IV	
July 29, 1952	4.81	4.80	3.90	3.50	4.25
August 29	3.03	2.17	2.91	3.44	2.88
September 29	2.08	2.13	2.21	2.15	2.14
October 29	2.33	2.00	2.26	2.20	2.19
November 29	1.94	2.23	2.03	2.23	2.10
December 29	3.04	3.81	3.66	3.30	3.45
January 29, 1953	4.73	4.74	4.19	4.18	4.46
February 28	3.87	3.80	4.21	3.80	3.92
March 29	6.76	5.21	4.63	3.56	5.04
April 29	4.99	4.84	5.43	4.92	5.04
May 29	4.55	5.50	6.71	6.52	5.82
June 29	6.17	4.88	4.33	4.98	5.09

TABLE 7

Weather conditions during the experiment

MONTH	RAINFALL (INCH)		TEMPERATURE (°C.)			HUMIDITY (%)	
	Range	Total	Min.	Max.	Av.	Range	Av.
July	0–0.65	5.81	25.8	30.9	28.34	68.8–86.3	77.56
August	0–4.40	17.93	23.6	29.1	27.41	77.0–95.5	91.90
September	0–1.27	7.72	24.2	29.1	26.32	82.6–100	87.08
October	0–6.18	21.26	23.6	29.5	26.54	76.0–94.7	85.39
November	0–1.92	3.18	24.2	27.7	26.67	29.5–95.0	86.43
December	0–4.00	9.44	23.9	27.3	25.51	75.0–93.7	85.37
January	0–0.92	0.81	23.0	27.4	25.02	75.7–92.5	82.06
February	0–1.31	2.64	23.6	27.3	25.49	68.6–92.8	77.30
March	0–0.55	1.33	25.4	29.9	27.65	62.0–87.3	72.22
April	0–0.10	0.15	24.2	31.5	29.26	60.8–72.5	67.28
May	0–1.39	6.22	26.3	32.5	29.98	68.8–86.8	76.54
June	0–3.04	9.68	23.9	31.9	29.34	64.3–96.7	75.59

THE INFLUENCE OF IRRIGATION ON THE GROWTH, YIELD, AND SIZE OF LEAVES OF A VIRGINIA VARIETY OF TOBACCO [1]

ANDRES P. AGLIBUT and JOSE A. EUSEBIO

WITH ONE TEXT FIGURE

Plants of a Virginia variety of tobacco each irrigated with 1.13 to 10.61 liters, or 1.22 to 11.42 hectare-centimeters, at intervals of two to four days had better growth and produced more leaves and a heavier crop of cured leaves than the unirrigated plants. The yield of the surface-irrigated tobacco plants was higher when light to heavy irrigations were applied at more frequent intervals than at longer intervals. The best yield of cured leaves was produced when each tobacco plant was irrigated with an average of 208.6 liters (224.6 hectare-centimeters) of water in addition to 12 centimeters of rainfall during the period of growth. The largest leaves were produced when each plant was irrigated with 7.45 liters (8.02 hectare-centimeters) once in two days. However, more uniform leaves were obtained from the plants irrigated with 10.61 liters (11.42 hectare-centimeters).

Although irrigating tobacco soil with 20 to 50 per cent saturation in addition to 12 centimeters of rainfall seemed to satisfy the water requirement of surface-irrigated Virginia tobacco, it is recommended that heavier irrigations than the amounts used in this study be tried to determine if heavier applications can be used at longer intervals to produce the same or better results than those obtained in this study.

Irrigation of tobacco has been done for many years in the Philippines, particularly in the older established areas in Isabela and Cagayan. The number and quantity of irrigations have been dependent on the season.

Lovett (1953) obtained the best results from 1.0 to 1.5 acre-inches (2.54 to 3.81 hectare-centimeters) of water for plant establishment in the field, followed by a total irrigation of approximately 200 acre-inches (508 hectare-centimeters) during growth. He found that heavy application retarded early growth and tended to affect adversely yield but not quality. With low watering, plants were stunted and failed to ripen satisfactorily, whereas high rates were above the optimum for yield and quality.

La Padre and Carr (1943) reported that a monthly rainfall of 3.15 to 4.21 inches is ideal for excellent yield and quality of tobacco in average tobacco soil.

Aglibut and Torreda (1950) found that surface irrigation of 4.14 to 8.20 liters for each plant or 4.41 to 8.82 hectare-centimeters applied around the plants produced better growth of filler variety of

[1] Central Experiment Station Contribution No. 1767. Taken from the thesis presented by the junior author for graduation, April, 1954, with the degree of Bachelor of Science in Agriculture from the College of Agriculture. Prepared in the Department of Agricultural Engineering under the direction of the senior author.

Philippine tobacco. They concluded that tobacco plants give better yield when light but frequent irrigations or heavy but less frequent irrigations are applied.

Galang and Panganiban (1949) reported that a two-year test points to the fact that the optimum water requirement of tobacco is 60 per cent saturation. With 50 per cent saturation the height of the tobacco plant on alluvial soil was 2.28 centimeters less (except the leaves) than that obtained with 60 per cent; with 80 per cent saturation, it was 5.89 centimeters less.

A study to determine the influence of different amounts and frequencies of irrigation on the growth, yield, and size of leaves of a Virginia variety of tobacco was conducted in the experimental yard beside the Agricultural Botany building, in the laboratory of the Department of Agronomy, and in the Department of Agricultural Engineering from December, 1952, to March, 1954.

MATERIALS AND METHODS

Plan of the experiment. The experimental land was well plowed, harrowed, and leveled. Seventeen rows, 80 centimeters apart, were laid, and in each row ten 1-foot cube holes, 70 centimeters apart, were dug. The soil removed from the 170 holes was mixed and later placed back in equal quantities and uniform compactness in the holes. Each refilled hole served as a plant bed for one seedling.

There were 10 plants in a row, and to each row was assigned at random a corresponding irrigation treatment. The experimental design in the first and second replications was as follows:

AMOUNT OF IRRIGATION WATER APPLIED IN PERCENTAGE OF WATER-HOLDING CAPACITY OF THE SOIL AND IN LITERS	IRRIGATION TREATMENT	NUMBER OF PLANTS IN EACH FREQUENCY OF IRRIGATION [a]				TOTAL NUMBER OF PLANTS
		2	4	6	8	
0	Control					10
20 1.13 liters (1.22 hectare-centimeters)	1	10	10	10	10	40
30 4.29 liters (4.62 hectare-centimeters)	2	10	10	10	10	40
40 7.45 liters (8.02 hectare-centimeters)	3	10	10	10	10	40
50 10.61 liters (11.42 hectare-centimeters)	4	10	10	10	10	40
Total	4	40	40	40	40	170

[a] Irrigation was given once after interval indicated.

Determination of the water-holding capacity of the soil. An analysis made in the Department of Soils of a composite sample of

soil showed that, up to a depth of 1 foot, the soil had a water-holding capacity of 55.12 per cent, on the air-dry basis, and 60.60 per cent, on the oven-dry basis. The same composite soil had a moisture content of 9.05 per cent, air-dry basis, and a specific gravity of 2.02.

Irrigation. The computed amounts of irrigation water were based on the weight and the water-holding capacity of the soil placed in each hole. The seedlings were watered daily during the first week after transplanting. The experimental treatments were begun on the second week following transplanting. Irrigation water was applied with the use of calibrated gallon cans, around and as close to the base of the plants as possible, in the afternoons except on rainy days. Irrigation treatments were ended on May 15, 1953.

Transplanting. One-month-old tobacco seedlings of the C. A. 436 variety of Virginia tobacco were used in the first and second replications. They were transplanted in the afternoon of January 8, 1953, one vigorous seedling to each prepared bed. The seedlings were watered uniformly immediately after transplanting to give them a good start. They were covered with banana bracts, which were removed daily after sunset, during the first week following transplanting to protect them from wilting.

Care, harvesting, and curing. All the plants received the same care. The flower buds were not pinched off as the process might influence the yield of the plants. Harvesting was done by priming, or by picking the leaves singly from the stalks as they matured. The indications of leaf maturity were the turning yellow of the portions at and around the edges of the leaves, especially the tips, and the change in color of the leaves from dark green to lighter green.

Priming was done by the row in every treatment at about nine o'clock in the morning at weekly intervals. It took six primings to complete the harvest. The leaves were labeled and taken to the curing laboratory. The length of the leaves was measured from the tip to the base of the petiole, and the width was taken at the broadest part of the leaves.

The leaves were poled by using the Cuban method described by Paguirigan (1917). A big steel needle, threaded with two meters of string tied at one end to a wooden pole, was passed through the base of the midribs of the leaves, which were strung back to back so that they rode alternately on the pole. Every treatment had its own string hung on the curing rack and properly labeled. The air-cured leaves were weighed in the Department of Agricultural Engineering 10 to 20 days after harvesting. The indication of complete curing was the dessication of the midribs.

RESULTS AND DISCUSSION

Growth as influenced by amount and interval of irrigation. The same amount of irrigation applied at different intervals produced significant variations in growth of the Virginia variety of tobacco

plants (tables 1a, 1b, 1c). The more frequent application of three of the four irrigation treatments in the first replication produced better growth. The plants each irrigated with 1.13 liters (1.22 hectare-centimeters) showed slight variation in growth. Irrigations of 4.29 liters (4.62 hectare-centimeters), applied once every four days, and 7.45 liters (8.02 hectare-centimeters), applied once every two days, and 10.61 liters (11.42 hectare-centimeters), applied every two days, produced the best growths.

In the second replication, the first irrigation treatment of 1.13 liters (1.22 hectare-centimeters) did not produce the same plant growth as in the first replication. Applications at intervals of two days and eight days produced taller plants than applications at intervals of four days and six days. In the irrigation treatment of 4.29 liters (4.62 hectare-centimeters), the plants which were watered once every eight days were shorter than those watered every two, four, and six days. The plants each irrigated with 7.45 liters (8.02 hectare-centimeters) once every six days grew taller and faster than those irrigated at four- and eight-day intervals. The fourth treatment of 10.61 liters (11.42 hectare-centimeters) applied at two- and four-day intervals produced taller plants than when applied at six- and eight-day intervals.

Considering both replications and the irrigation treatment as a whole, the plants which were irrigated to 20, 30, 40, and 50 per cent saturation grew faster and taller than those which received no irrigation. When the means of the group treatments were compared with the control mean in table 1c, significant differences were evident. Only the 30 per cent saturation at four- and eight-day intervals and the 40 per cent saturation at two- and four-day intervals produced insignificant differences.

Number of leaves as influenced by amount and interval of irrigation. In the first replication, the amount of water applied to each plant and the interval of application which produced the most number and the highest average of leaves were as follows: 1.13 liters, two-day interval; 4.29 liters, two-day interval; 7.45 liters, two-day interval; and 10.61 liters, four-day interval (table 2a). The plants irrigated with 7.45 liters once every two days produced the highest average and the biggest total number of leaves.

In the second replication, almost identical results were observed (table 2b). The plants irrigated with 4.29 liters, applied at four- and six-day intervals, and with 7.45 liters, applied at two-day interval, gave the highest average number of leaves. When each plant was irrigated with 7.45 liters once in two days, the highest number of leaves and the highest average number of leaves to a plant were obtained. The unirrigated tobacco plants produced lower total and average numbers of leaves than the irrigated plants. Irrigation, then, has a significant influence on the productiveness of Virginia tobacco (table 2c). When the means of the group treatments of the irrigated

plants were compared, however, the differences within treatments were those from plants each irrigated with 7.45 liters (8.02 hectare-centimeters) once every two and every eight days.

Size of leaves as influenced by amount and frequency of irrigation. The size of leaves measured in terms of width and length appeared to be influenced by the amount and frequency of irrigation (fig. 1). In the first replication, the plants irrigated with 1.13 liters, 4.29 liters, and 7.45 liters at two-day interval produced the widest leaves (table 2a). The longest leaves were also produced by plants given the above treatments. When 7.45 liters was applied, the widest and longest leaves were produced by plants irrigated once every two and every eight days.

In the second replication (table 2b), the widest and longest leaves were harvested from the plants irrigated once every four days with 4.29 liters (4.62 hectare-centimeters). There seemed to be slight variations in the average width and length of leaves harvested from plants irrigated with 1.13 liters at two-, four-, six-, and eight-day intervals. Although the leaves from plants irrigated with 10.61 liters (11.42 hectare-centimeters) were comparatively narrower and shorter than those from the other irrigation treatments, they were more uniform in width and length.

Fig. 1.—Average sizes of leaves in the control and at 20, 30, 40, and 50 per cent saturation.

Different irrigation treatments of 20, 30, and 40 per cent saturation, air-dry basis, or 1.22, 4.62, and 8.02 hectare-centimeters, respectively, produced highly significant differences when compared with the control (table 2d). The plants irrigated with 1.13 liters and with 7.45 liters once in two and in eight days produced leaves significantly larger than those in any of the other treatments.

Weight of cured leaves as influenced by irrigation. All irrigation treatments produced higher total weights of cured leaves than the unirrigated lot (tables 2a and 2b). Similarly, the irrigated plants

gave higher average weights of cured leaves than the control plants, with the exception of two of the 16 treatments.

In the first replication, the highest total and average yields of cured leaves were obtained from the plants each irrigated with 7.45 liters of water at two-day interval. The second highest yield of cured leaves was produced by the plants irrigated with 4.29 liters once every two days. However, more uniform weight of cured leaves was produced when 1.13 liters of water was applied to each plant at different intervals.

In the second replication, the highest yield of cured leaves was harvested from the plants irrigated at the rate of 7.45 liters to a plant (8.02 hectare-centimeters) applied once every two days. The next heaviest crop was obtained from the plants irrigated with 4.29 liters (4.62 hectare-centimeters) once in four days. Almost the same pattern of yield variation of the plants in the first replication was obtained in the second replication, the heavier yields being produced by those receiving more frequent irrigations.

With lighter irrigations, more frequent applications produced a heavier crop than less frequent applications. Similarly, heavier irrigations applied more frequently produced better yield of cured leaves than the same amounts applied at longer intervals. Comparison of the means within treatments showed that the plants irrigated with 7.45 liters (8.02 hectare-centimeters) once in two days produced significantly heavier cured leaves than those from the other treatments (table 2e).

Plant mortality. In tables 3a and 3b is shown the mortality among the tobacco plants in both replications. Observations were made on the unusual variation in resistance among the tobacco plant cultures. In the fourth week after transplanting, there was a scattered attack of tobacco cutworm, *Prodenia litura* Fabr.[2] The pest was controlled after the plants were sprayed with 5 per cent DDT solution.[3] Root knot of tobacco, *Heterodera radicicola* Greef,[4] caused a large percentage of deaths. Mottling and curling of the leaves were observed, possibly caused by the disease. Leafspot or frogeye disease caused by *Cercospora nicotianae* Ell and Evht [4] also added to the plant mortality.

In the first replication, the highest mortality in the control was observed on the tenth and on the fourteenth week. Among the irrigated cultures, that given 1.13 liters once every eight days had the highest mortality. Most of the deaths among the cultures irrigated with 1.13 liters, 7.45 liters, and 10.61 liters took place in the later part of the experiment. The deaths might have been due partly to excessive rainfall since the plants started to wilt soon after the rain; no pest or disease was observed. The death of plants in the

[2] Identified by Dr. S. M. Cendaña of the Department of Entomology.

[3] The spray was recommended and supplied by Dr. G. B. Viado of the Deparment of Entomology.

[4] Identified by Dr. F. T. Orillo of the Department of Plant Pathology.

unirrigated plots, however, was due to the attack of root knot of tobacco.

In the second replication, the highest mortality occurred in the control and in the cultures irrigated with 4.29 liters once in eight days and with 7.45 liters once in four days. The deaths might have been due to injuries suffered by the seedlings at transplanting because there was no indication of the presence of pest or disease. There was no mortality during the period of observation in the cultures irrigated with 1.13 liters (1.22 hectare-centimeters).

Weather observations. The meteorological observations (table 4) during the period was made at the College of Agriculture weather station located about fifty meters from the tobacco cultures. The total precipitation of 12 centimeters occurred in 36 rainy days from January to April, 1953. The 10 days' rainfall of 2.9 centimeters in March which fell after the development stage was observed to increase and vigor and height of the plants, but the two days' precipitation of 0.32 centimeter in April which fell past the flowering stage did not influence the flowering of the plants.

It was observed that the temperature ranged from 22.9°C. to 33.3°C. during the period of growth. The average relative humidity was 74.27 per cent and the average temperature range was 24.25°C. to 30.3°C.

Water requirement. The growth, yield, and size of leaves of the C.A. 436 variety of Virginia tobacco were influenced by the amount of irrigation and interval of application. In table 5 is shown the total amount of water applied in each treatment and the precipitation from transplanting to maturity of the tobacco plants. In addition to the total rainfall of 12 centimeters during the period, irrigations of 1.13 liters to 10.61 liters (1.22 hectare-centimeters to 11.42 hectare-centimeters), or 20 to 50 per cent saturation, based on the water-holding capacity of the soil, air-dry basis, produced better rate of growth of the tobacco plants, longer and wider leaves, and a heavier crop of cured leaves than the control. It was also found that the above amounts of irrigation water produced better growth, yield, and size of leaves when applied at short intervals of two to four days.

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TABLE 1a

Average weekly height of tobacco plants grown at different rates and intervals of irrigation, first replication

AMOUNT OF IRRIGATION	INTERVAL	NUMBER OF PLANTS	INITIAL HEIGHT	AVERAGE WEEKLY HEIGHT IN CENTIMETERS														TOTAL GROWTH INCREMENT
				Weeks														
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	
liters	*days*		*cm.*															
0	none	5	2.77	7.15	7.17	10.47	12.56	17.58	21.91	24.74	31.82	37.65	46.30	57.02	63.52	66.51	96.30	93.53
	2	10	2.21	5.25	8.58	14.19	17.85	26.11	35.84	44.24	51.36	63.08	73.59	80.15	92.10	98.25	99.30	97.09
1.13	4	10	2.16	5.11	9.01	14.51	17.94	26.55	33.22	40.10	46.95	52.15	65.66	75.16	83.19	106.00	106.30	104.14
(1.22	6	10	2.17	3.82	6.99	12.44	15.21	23.71	31.48	37.00	44.83	58.25	66.53	73.46	81.37	95.35	95.95	93.78
ha.-cm.)	8	6	2.40	5.67	6.81	9.43	13.96	15.23	23.77	30.03	38.82	48.44	54.33	61.20	73.47	87.87	92.78	90.38
	2	10	2.17	5.29	10.17	14.12	18.28	27.35	36.21	45.30	53.90	66.72	77.70	88.01	98.47	115.90	116.75	114.58
4.29	4	9	2.71	5.81	8.52	13.66	16.13	22.63	35.73	42.93	51.07	61.32	72.08	81.66	95.57	117.79	128.16	125.45
(4.62	6	10	2.29	4.23	6.88	12.17	14.78	23.54	29.67	35.91	40.80	57.08	59.43	65.55	75.42	90.50	90.95	88.66
ha.-cm.)	8	8	2.07	2.94	3.45	5.94	8.80	16.33	22.07	25.81	33.63	44.93	53.69	61.71	71.27	84.25	84.25	82.76
	2	10	2.66	4.96	9.30	14.98	18.57	26.31	35.78	46.17	57.65	68.95	80.93	91.99	105.17	122.00	122.81	120.15
7.45	4	7	3.10	5.56	10.09	16.11	18.85	24.85	29.87	34.12	42.16	50.94	54.97	58.13	66.09	70.20	79.08	75.98
(8.02	6	10	2.68	4.64	7.79	14.55	15.96	23.07	28.78	35.84	40.53	54.42	61.12	65.33	74.47	90.49	96.86	94.18
ha.-cm.)	8	9	2.80	3.27	4.07	6.90	10.97	17.45	25.03	29.75	39.33	54.91	65.85	73.13	86.43	93.44	93.88	91.08
	2	7	2.68	8.76	13.57	17.51	20.33	25.11	36.34	48.11	52.38	66.60	71.88	80.82	87.33	91.33	109.68	107.00
10.61	4	7	2.37	8.68	13.71	18.23	20.86	24.10	30.26	36.94	46.17	56.70	69.63	79.83	81.67	91.67	91.67	89.30
(11.42	6	9	2.25	5.90	8.27	11.60	13.45	19.33	22.69	35.47	41.95	49.88	56.13	62.37	69.71	70.66	80.66	78.41
ha.-cm.)	8	8	3.14	5.22	8.06	12.70	16.05	24.42	28.83	31.20	34.08	42.38	47.21	56.92	70.78	83.65	83.65	80.51

TABLE 1b

Average weekly height of tobacco plants grown at different rates and intervals of irrigation, second replication

AMOUNT OF IRRIGATION	INTERVAL	NUMBER OF PLANTS	INITIAL HEIGHT	AVERAGE WEEKLY HEIGHT IN CENTIMETERS														TOTAL GROWTH INCREMENT
				Weeks														
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	
liters	*days*		*cm.*															
0	none	8	2.82	6.13	6.35	8.10	9.76	14.65	22.79	29.96	36.19	47.76	55.39	63.06	64.56	79.06	78.68	75.86
	2	10	2.18	4.92	8.24	11.07	13.95	22.02	28.40	34.38	40.45	51.55	59.48	68.25	81.64	101.78	102.20	100.02
1.13	4	10	2.15	5.34	8.48	12.82	14.82	21.81	30.20	34.80	41.33	50.16	60.02	66.72	76.83	95.39	95.98	93.83
(1.22	6	10	2.55	4.48	5.78	8.51	10.56	15.95	24.20	30.08	36.00	45.80	52.65	59.25	67.95	83.65	85.52	82.97
ha.-cm.)	8	10	2.63	5.80	7.93	11.14	14.75	21.89	30.46	38.04	44.10	55.19	63.55	73.65	81.57	105.80	107.17	104.54
	2	10	2.49	3.48	7.94	11.36	15.36	23.32	31.12	38.53	42.67	55.87	68.00	75.52	85.25	101.80	103.40	100.91
4.29	4	9	2.33	6.37	10.38	16.99	21.69	31.03	41.10	49.97	58.94	72.83	82.78	91.50	98.73	131.67	131.89	129.56
(4.62	6	10	2.55	6.94	11.03	15.63	18.24	24.58	34.03	41.92	49.31	62.39	72.27	83.20	96.28	121.50	125.90	123.35
ha.-cm.)	8	8	2.43	3.10	3.58	4.72	7.55	11.66	16.55	22.28	27.44	37.11	44.75	54.79	67.33	87.00	87.00	84.65
	2	9	2.25	4.84	11.10	15.46	19.14	26.42	36.39	47.58	53.94	68.73	80.92	90.58	100.18	133.37	135.88	133.63
7.45	4	8	2.23	3.00	7.03	9.31	13.26	18.70	24.41	31.33	34.50	42.36	50.98	53.88	67.00	80.00	81.83	79.60
(8.02	6	9	2.60	5.79	9.22	13.22	17.09	24.51	34.89	43.81	49.42	65.14	73.81	81.33	89.08	110.11	115.77	113.17
ha.-cm.)	8	9	2.42	4.23	4.94	6.93	9.91	15.72	21.31	27.08	31.92	40.72	49.74	56.22	65.53	82.00	82.38	79.96
	2	10	2.52	8.16	13.24	19.03	24.05	24.88	41.51	51.43	58.50	77.72	84.14	91.01	104.85	118.70	119.35	116.83
10.61	4	10	2.64	5.52	9.37	12.99	16.65	22.42	32.58	39.42	46.33	57.50	67.14	76.30	88.25	106.40	106.70	104.06
(11.42	6	10	2.22	4.84	6.99	11.08	13.20	19.98	25.64	31.48	36.08	45.92	53.65	59.85	70.65	84.10	84.45	82.23
ha.-cm.)	8	9	2.23	2.85	3.73	5.39	9.49	13.49	18.98	25.51	30.64	42.07	48.19	61.43	70.07	74.56	79.67	77.44

TABLE 1c

Height on 14th week of tobacco plants irrigated at different rates and intervals

AMOUNT OF IRRIGATION	INTERVAL	AVERAGE HEIGHT ON 14TH WEEK		MEAN
		Replication I	Replication II	
liters	*days*			
0	none	69.30	78.68	73.99
1.13 (1.22 ha.-cm.)	2	99.30	102.20	100.75
	4	106.30	95.98	101.14
	6	95.95	85.52	90.73
	8	92.78	107.17	99.97
4.29 (4.62 ha.-cm.)	2	116.75	103.40	110.07
	4	128.16	131.89	130.02
	6	90.95	125.90	108.42
	8	84.83	87.08	85.95
7.45 (8.02 ha.-cm.)	2	122.81	135.88	131.84
	4	79.08	81.83	80.45
	6	96.86	115.77	106.31
	8	93.88	82.38	88.13
10.61 (11.42 ha.-cm.)	2	109.68	119.35	114.51
	4	91.67	106.70	99.18
	6	80.66	84.45	82.50
	8	83.65	79.67	81.66

Analysis of variance

SOURCE OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Block	1	170.96	170.96			
Treatment	16	8,904.83	556.55	7.10 [a]	2.33	3.37
Error	16	1,253.84	78.36			
Total	33	10,329.63				

L.S.M.D. = 18.77

[a] Highly significant.

TABLE 2a

Number, size, and weight of leaves harvested from tobacco plants given different rates and intervals of irrigation, first replication

AMOUNT OF IRRIGATION	INTERVAL	NUMBER OF PLANTS	NUMBER OF LEAVES		AVERAGE SIZE OF LEAVES		WEIGHT OF CURED LEAVES	
			Total	Average	Width	Length	Total	Average
liters	*days*				*cm.*	*cm.*	*grams*	*grams*
0	none	5	57	11.4	12.36	23.28	133.4	26.68
1.13 (1.22 ha.-cm.)	2	10	137	13.7	21.12	40.60	369.5	36.95
	4	10	129	12.9	19.24	37.83	347.0	34.70
	6	10	114	11.4	18.89	38.65	367.5	36.75
	8	6	83	13.8	15.84	28.93	201.7	33.62
4.29 (4.62 ha.-cm.)	2	10	144	14.4	21.99	41.10	418.6	41.86
	4	9	121	13.4	18.27	35.27	315.8	35.09
	6	10	132	13.2	18.75	36.61	394.7	39.47
	8	8	98	12.3	19.03	35.40	219.7	27.46
7.45 (8.02 ha.-cm.)	2	10	157	15.7	20.89	40.01	464.1	46.41
	4	7 [a]	96	13.7	15.93	31.47	142.7	20.39
	6	10	123	12.3	17.83	35.14	280.3	28.03
	8	9	111	12.3	19.63	37.60	260.4	28.93
10.61 (11.42 ha.-cm.)	2	7	93	13.3	17.98	36.08	225.8	32.26
	4	7 [a]	102	14.6	15.68	31.71	272.3	38.90
	6	9	81	9.0	15.36	29.82	241.3	26.81
	8	8	84	10.5	17.03	34.61	183.4	22.93

[a] Attacked by disease.

TABLE 2b

Number, size, and weight of leaves harvested from tobacco plants given different rates and intervals of irrigation, second replication

AMOUNT OF IRRIGATION	INTERVAL	NUMBER OF PLANTS	NUMBER OF LEAVES		AVERAGE SIZE OF LEAVES		WEIGHT OF CURED LEAVES	
			Total	Average	Width	Length	Total	Average
liters	*days*				*cm.*	*cm.*	*grams*	*grams*
0	none	8	83	10.4	16.48	31.19	195.9	24.49
1.13 (1.22 ha.-cm.)	2	10	141	14.1	19.17	36.80	371.5	37.15
	4	10	133	13.3	18.11	35.72	325.8	32.58
	6	10	139	13.9	18.04	34.35	362.6	36.26
	8	10	134	13.4	18.03	35.20	279.3	27.93
4.29 (4.62 ha.-cm.)	2	10	149	14.9	18.94	37.38	371.8	37.18
	4	9	141	15.7	21.21	41.92	421.6	46.84
	6	10	156	15.6	19.93	40.42	418.6	41.86
	8	8	102	12.8	17.73	34.01	200.4	25.05
7.45 (8.02 ha.-cm.)	2	9	149	16.6	21.65	41.48	454.1	50.46
	4	8	101	12.6	16.44	34.31	142.7	17.84
	6	9	126	14.0	19.70	38.24	330.9	36.77
	8	9	116	12.9	17.74	34.44	245.8	27.31
10.61 (11.42 ha.-cm.)	2	10	127	12.7	18.31	37.97	299.3	29.93
	4	10	144	14.4	20.44	39.50	385.4	38.54
	6	10	133	13.3	17.62	35.43	280.5	28.05
	8	9	123	13.7	17.10	32.54	190.9	21.21

TABLE 2c

Number of leaves harvested from tobacco plants given different rates and intervals of irrigation

AMOUNT OF IRRIGATION	INTERVAL	AVERAGE NUMBER OF HARVESTED LEAVES		MEAN
		Replication I	Replication II	
liters	*days*			
0	none	11.4	10.4	10.9
1.13 (1.22 ha.-cm.)	2	13.7	14.1	13.9
	4	12.9	13.3	13.1
	6	11.4	13.9	12.6
	8	13.8	13.4	13.6
4.29 (4.62 ha.-cm.)	2	14.4	14.9	14.6
	4	13.4	15.7	14.5
	6	13.2	15.6	14.4
	8	12.3	12.8	12.5
7.45 (8.02 ha.-cm.)	2	15.7	16.6	16.1
	4	13.7	12.6	13.1
	6	12.3	14.0	13.1
	8	12.3	12.9	12.6
10.61 (11.42 ha.-cm.)	2	13.3	12.7	13.0
	4	14.6	14.4	14.5
	6	9.0	13.3	11.1
	8	10.5	13.7	12.1

Analysis of variance

SOURCE OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Block	1	7.97	7.97			
Treatment	16	56.22	3.51	2.98 [a]	2.33	3.37
Error	16	18.87	1.18			
Total	33	83.00				

L.S.M.D. = 2.30

[a] Significant at 5 per cent level.

TABLE 2d

Average area in centimeters of leaves harvested from tobacco plants given different rates and intervals of irrigation

AMOUNT OF IRRIGATION	INTERVAL	AVERAGE AREA ON 14TH WEEK		MEAN
		Replication I	Replication II	
liters	*days*			
0	none	287.74	514.01	400.88
1.13 (1.22 ha.-cm.)	2	857.47	705.46	781.47
	4	727.85	646.89	687.37
	6	730.09	619.67	674.88
	8	458.25	634.66	546.46
4.29 (4.62 ha.-cm.)	2	903.79	707.98	805.89
	4	644.28	889.12	766.75
	6	686.84	805.57	746.01
	8	673.66	603.00	638.33
7.45 (8.02 ha.-cm.)	2	835.80	898.04	866.92
	4	501.32	564.06	532.94
	6	626.55	753.33	689.94
	8	738.09	610.97	674.53
10.61 (11.42 ha.-cm.)	2	645.47	695.23	670.35
	4	497.21	807.38	652.13
	6	458.04	624.28	541.16
	8	589.41	556.43	572.92

Analysis of variance

SOURCE OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Block	1	17,643.57	17,643.57			
Treatment	16	436,523.41	27,282.71	2.34 [a]	2.33	3.32
Error	16	186,828.66	11,676.79			
Total	33	641,045.64				

L.S.M.D. = 228.75

[a] Significant at 5 per cent level.

TABLE 2e

Average weight in grams of cured leaves harvested from tobacco plants given different rates and intervals of irrigation

AMOUNT OF IRRIGATION	INTERVAL	AVERAGE WEIGHT OF CURED LEAVES		MEAN
		Replication I	Replication II	
liters	*days*			
0	none	26.70	24.48	25.59
1.13 (1.22 ha.-cm.)	2	36.95	37.15	37.05
	4	34.70	32.58	33.64
	6	36.75	36.26	36.50
	8	33.62	27.93	30.77
4.29 (4.62 ha.-cm.)	2	41.86	37.18	39.52
	4	35.08	46.84	40.96
	6	39.47	41.84	40.65
	8	27.46	25.05	26.25
7.45 (8.02 ha.-cm.)	2	46.41	50.45	48.43
	4	20.39	17.84	19.11
	6	28.03	36.77	32.40
	8	28.93	27.31	28.12
10.61 (11.42 ha.-cm.)	2	32.26	29.93	31.09
	4	38.90	38.54	38.72
	6	26.81	28.05	27.43
	8	22.93	21.21	22.07

Analysis of variance

SOURCE OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Block	1	0.14	0.14			
Treatment	16	1,888.78	118.05	11.85 [a]	2.33	3.37
Error	16	159.40	9.96			
Total	33	2,040.32				

L.S.M.D. = 6.69

[a] Highly significant.

TABLE 3a

Weekly record of the living plants in the first replication

AMOUNT OF IRRIGATION	INTERVAL	FIRST DAY	NUMBER OF WEEKS AFTER TRANSPLANTING														MORTALITY	
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	Number of plants	Percentage
liters	*days*																	
0	none	10	10	9	9	8	8	8	8	8	8	6	6	6	6	5	5	50
1.13	2	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	0	0
(1.22 ha.-cm.)	4	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	0	0
	6	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	0	0
	8	10	10	10	10	10	10	10	10	9	8	6	6	6	6	6	4	40
4.29	2	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	0	0
(4.62 ha.-cm.)	4	10	10	10	10	10	10	10	10	10	10	10	10	9	9	9	1	10
	6	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	0	0
	8	10	9	8	8	8	8	8	8	8	8	8	8	8	8	8	2	20
7.45	2	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	0	0
(8.02 ha.-cm.)	4	10	10	10	10	10	10	10	9	9	9	9	9	8	8	7	3	30
	6	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	0	0
	8	10	10	10	10	10	10	10	10	10	10	9	9	9	9	9	1	10
10.61	2	10	10	10	10	10	10	10	9	9	9	8	7	7	7	7	3	30
(11.42 ha.-cm.)	4	10	10	10	10	10	10	9	8	8	7	7	7	7	7	7	3	30
	6	10	10	10	10	10	10	10	10	10	10	10	10	9	9	9	1	10
	8	10	10	9	9	9	9	9	9	9	9	8	8	8	8	8	2	20

TABLE 3b

Weekly record of the living plants in the second replication

AMOUNT OF IRRIGATION	INTERVAL	FIRST DAY	NUMBER OF WEEKS AFTER TRANSPLANTING														MORTALITY	
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	Number of plants	Percentage
liters	*days*																	
0	none	10	9	8	8	8	8	8	8	8	8	8	8	8	8	8	2	20
1.13 (1.22 ha.-cm.)	2	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	0	0
	4	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	0	0
	6	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	0	0
	8	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	0	0
4.29 (4.62 ha.-cm.)	2	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	0	0
	4	10	9	9	9	9	9	9	9	9	9	9	9	9	9	9	1	10
	6	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	0	0
	8	10	9	8	8	8	8	8	8	8	8	8	8	8	8	8	2	20
7.45 (8.02 ha.-cm.)	2	10	9	9	9	9	9	9	9	9	9	9	9	9	9	9	1	10
	4	10	10	10	10	9	9	9	8	8	8	8	8	8	8	8	2	20
	6	10	10	10	10	9	9	9	9	9	9	9	9	9	9	9	1	10
	8	10	10	10	9	9	9	9	9	9	9	9	9	9	9	9	1	10
10.61 (11.42 ha.-cm.)	2	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	0	0
	4	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	0	0
	6	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	0	0
	8	10	10	10	10	10	9	9	9	9	9	9	9	9	9	9	1	10

TABLE 4

Weather observations from transplanting to maturity of tobacco plants [a]

PERIOD OF OBSERVATION	TEMPERATURE		MEAN RELATIVE HUMIDITY	RAINFALL		CLOUDINESS
	Mean Minimum	Mean Maximum		Total	Distribution	
1953	*°C.*	*°C.*	*per cent*	*cm.*	*days*	
January	22.95	27.96	79.39	2.07	10	5.95
February	23.42	28.71	77.90	6.72	14	7.08
March	24.55	31.28	72.40	2.89	10	6.13
April	26.06	33.26	67.40	0.32	2	4.16
Total				12	36	23.32
Average	24.25	30.30	74.27	3.0	9.0	5.83

[a] Made at the College of Agriculture.

TABLE 5

Total amount of water applied and periodic precipitation from transplanting to maturity of tobacco plants

INTERVAL	TOTAL AMOUNT IN LITERS OF IRRIGATION APPLIED				RAINFALL	
	20 per cent	30 per cent	40 per cent	50 per cent	Total	Distribution
days					*cm.*	*days*
2	31.64	120.12	208.60	297.08		
4	23.73	90.09	156.45	222.81		
6	14.96	55.77	96.85	137.93		
8	12.43	47.19	81.95	116.71	12.0	36

COLLEGE AND ALUMNI NOTES

Mr. Harold Stassen, of the FOA, Washington, and Col. Harry Brenn, of the FOA, Manila, visited the College on February 25, 1954. Other FOA visitors were Mr. Carl Fritzsche, of Thailand, and Mr. John Deal, of Burma, who came on March 2, 1954.

Mr. James P. Emerson, assistant chief, Agricultural Division, FOA, Manila, gave a talk on audio-visual aids to the students taking agricultural extension on March 2, 1954.

The nineteenth initiation exercises of the Society for the Advancement of Research was held on March 5, 1954. The new associate members are Ricardo M. Lantican, Concepcion L. Valera, and Marcos R. Vega. The new active members are Alejandro B. Catambay and Juan O. Unite. Fifteen members of the Society of Sigma Xi were made members of the society by affiliation. The incoming officers of the society are Nicolas L. Galvez, president; Faustino Q. Otanes, vice-president; Jose R. Velasco, secretary; and Pedro A. Rodrigo, Treasurer.

The UP Rural High School staff and resident alumni held a benefit literary-musical program on the evening of February 26, 1954. Two one-act plays were presented: "Help Wanted" by Domingo F. Nolasco and "Sino Ba Kayo?" by Julian Cruz Balmaceda. The proceeds were donated to the UPRHS Silver Jubilee fund.

The following papers were read and discussed at the regular scientific meeting of the Los Baños Biological Club on February 26, 1954: "Increment in body temperature and respiration of Philippine steers after plowing," by Dr. Valente Villegas; and "Cadang-cadang of coconut, as seen by a stranger," by Dr. George C. Kent.

A large group of Girl Scouts and high school students of the Quezon Provincial High School, Lucena, Quezon, visited the College recently. Miss Lourdes M. Gruela, of the Department of Agricultural Botany, and Prof. N. B. Tablante, of the Department of Agricultural Economics, gave lectures to the group.

The Junior-Senior prom of the UP Rural High School was held on February 20, 1954, at the Molawin Mess Hall. Leonida Lapis is the president and Miss Patrocinio V. Santos, the adviser, of the junior class. The senior president is Melanio Domdom and the adviser, Mr. Martin V. Jarmin.

Atty. Cornelio V. Crucillo, '25, was recently designated acting director of the Bureau of Plant Industry. At the time of his appointment he was assistant to the executive secretary of the PHILCUSA.

Upon the request of Congressman Eulogio Rodriguez, Jr., '25, chairman of the committee on agriculture in the House of Representatives, the following members of the faculty conferred with him at the

Legislative Building on economic matters affecting agriculture which may be remedied through proper legislation: Dr. Lynn S. Robertson, Prof. Nathaniel B. Tablante, '46, and Dr. Francisco M. Sacay, '25.

Mr. Eligio J. Tavanlar, '26, chairman of the board of directors of the LASEDECO, was on the campus on March 15, 1954. He brought with him four architects and engineers who will design the building to be erected by alumni and friends in honor of the late President Gonzalez. Engineer Tavanlar is taking charge of the planning of the memorial at his expense.

Dr. Alexander Gordon, '23, president of the Philippine Society of Agricultural Engineers, gave the opening address at the Agricultural Engineering and Soil Science Convention, which was held last February in Manila. The other alumni who took prominent part in the convention were Congressman Eulogio Rodriguez, Jr., '25, Alejandro B. Catambay, '24, Isidoro A. Romero, '41, Dominador Z. Rosell, '28, Alfredo Barrera, '35, Jesus P. Mamisao, '30, Ricardo T. Marfori, '30, Martin S. Celino, '29, and Alfonso Q. Briones, '29.

The College constantly receives requests for names of graduates who can be appointed to executive or supervisory positions in government and private agencies. These requests specify the qualification and experience of men desired. For lack of up-to-date records about graduates, many deserving ones have missed opportunities. Alumni are, therefore, requested to notify the Dean, the Secretary of the College, or the Monthly Bulletin about changes in positions and addresses.

The total enrollment in the College of Agriculture for the summer of 1954 is 669, excluding 2 cross-registrants from the Graduate School, U.P., Diliman, Q.C.:

Freshmen (new students, 43)	79
Sophomores (new students, 3)	226
Juniors (new students, 2)	152
Seniors	202
Postgraduates	7
Special students (new students, 2)	3
Total	669
Cross-registrants from the Graduate School, U. P., Diliman, Q. C.	2